

ND-1195 280

IMPROVING LOW TEMPERATURE STARTABILITY OF M113
VEHICLES: HOT AIR HEATING TESTS(U) DEFENCE RESEARCH
ESTABLISHMENT SUFFIELD RALSTON (ALBERTA)

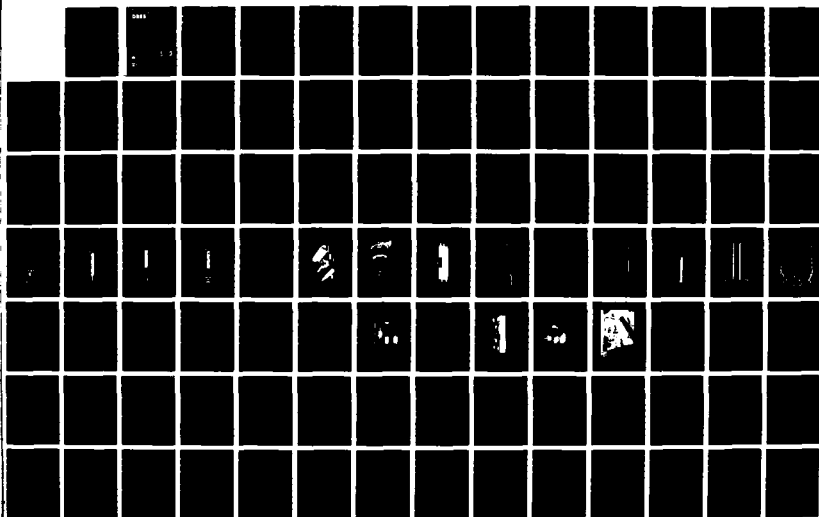
173

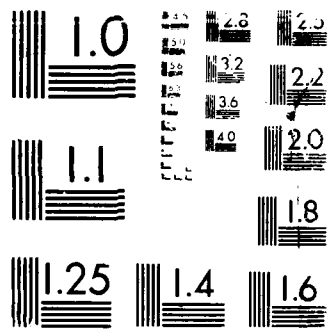
UNCLASSIFIED

T F STUPICH ET AL. MAR 88 DRES-SM-1163

F/G 19/3

NL





MACROGRAPH RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



National
Defence

Défense
nationale

UNCLASSIFIED

3

DTIC FILE COPY

DRES

UNLIMITED
DISTRIBUTION
ILLIMITÉE

SUFFIELD MEMORANDUM

NO. 1165

AD-A195 280

IMPROVING LOW TEMPERATURE STARTABILITY OF M113 VEHICLES: HOT AIR HEATING TESTS (U)

by

T.F. Stupich, V.S. Shankhla and W.G. Förster^{le}

ACN 27A71

March 1988

DTIC
ELECTE
MAY 05 1988
S_aH D



DEFENCE RESEARCH ESTABLISHMENT SUFFIELD, RALSTON, ALBERTA

Canada

WARNING

"The use of this information is permitted subject to
recognition of proprietary and patent rights."

DISTRIBUTION STATEMENT A

Approved for public release;
Distribution Unlimited

88

8

04

047

UNCLASSIFIED

UNLIMITED
DISTRIBUTION
ILLIMITEE

DEFENCE RESEARCH ESTABLISHMENT SUFFIELD
RALSTON, ALBERTA

SUFFIELD MEMORANDUM NO. 1165

IMPROVING LOW TEMPERATURE STARTABILITY OF M113 VEHICLES:
HOT AIR HEATING TESTS

by

T.F. Stupich
V.S. Shankhla
W.G. Förster

ACN 27A71

WARNING

"The use of this information is permitted subject to
recognition of proprietary and patent rights".

UNCLASSIFIED

UNCLASSIFIED

DEFENCE RESEARCH ESTABLISHMENT SUFFIELD
RALSTON, ALBERTA

SUFFIELD MEMORANDUM NO. 1165

IMPROVING LOW TEMPERATURE STARTABILITY OF M113 VEHICLES:
HOT AIR HEATING TESTS

by

T.F. Stupich
V.S. Shankhla
W.G. Förster

ABSTRACT

Tests were conducted to determine the effect of hot air heating systems on the temperatures and the starting ability of the Canadian Forces M113A1 Armoured Personnel Carrier. Results showed that M113 vehicles require heating in order to start at temperatures below -12°C . Two hot air heating systems proved to be capable of enabling vehicle starting at -16°C , which, because of unusually warm ambient conditions, was the lowest temperature that occurred during testing. One of the heating systems supplied hot air to the combustion air intake, and results suggest that this method may be capable of enabling starting at moderately cold temperatures (down to $\sim -25^{\circ}\text{C}$). The other system, which supplied hot exhaust gases to the engine compartment and hot exhaust-free air to the batteries and personnel compartment, appeared as though it would be capable of enabling vehicle starting at much lower temperatures. However, there was a significant amount of waste heat associated with using hot air to warm the engine

(i)

UNCLASSIFIED

UNCLASSIFIED

on the vehicle and the condensation inherent to heating with exhaust gases caused serious problems. In addition, the Espar Swingfire pulse combustion heaters that were used as the heat source in both heating systems were found to be extremely unreliable.

UNCLASSIFIED

ACKNOWLEDGEMENTS

The authors wish to thank the Vehicle Technical Support Group at DRES, and in particular, Mr. W. Ferguson and Mr. K. Gerrard. Their diligence and mechanical and instrumentation skills contributed much to the success of this effort. The enthusiasm with which the 2PPCLI at Canadian Forces Base Winnipeg provided test vehicles, maintenance and field support is much appreciated. In addition, Major P.G.T. Collinge and Capt A.G. Lugg were instrumental in launching this project. Their enthusiasm and continued support are very gratefully acknowledged.



Accession For	
NTIS GRA&I	<input checked="checked" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By _____	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	

UNCLASSIFIED

<u>Table of Contents</u>	<u>Page No.</u>
ABSTRACT	(i)
ACKNOWLEDGEMENTS	(iii)
TABLE OF CONTENTS	(iv)
LIST OF TABLES	(v)
LIST OF FIGURES	(vi)
1.0 INTRODUCTION	1
2.0 OBJECTIVES	4
3.0 EQUIPMENT	5
3.1 Test Vehicles	5
3.2 Data Acquisition	5
3.3 Vehicle Heating	6
3.4 Fuel Conditioning	8
4.0 TEST PROCEDURE	9
5.0 RESULTS AND DISCUSSION	10
5.1 Heater Performance	11
5.2 Startability of Cold Soaked Vehicles	13
5.3 Vehicle Preheating	13
5.4 Starting Heated Vehicles	16
5.5 Required Heat Input	19
6.0 CONCLUSIONS.....	21
REFERENCES	
TABLES	
FIGURES	
APPENDICES: A. Data Summary for Vehicle	
B. Data Acquisition	
C. Data from Vehicle Equipped with a Hot Air Heating Heating System	
D. Data from Control Vehicle	

UNCLASSIFIED

LIST OF TABLES

TABLE 1 Tests Conducted Using Hot Air Systems

TABLE 2 Vehicle Starting Without Heating

TABLE 3 Effect of 15 Minutes of Heating on Vehicle Temperatures

TABLE 4 Vehicle Temperatures Corresponding to Successful and
Unsuccessful Engine Starting

(v)

UNCLASSIFIED

UNCLASSIFIED

LIST OF FIGURES

- FIGURE 1 Effect of Cranking Speed and Intake Air Temperature on Compression Temperature (Reference 3)
- FIGURE 2 Battery Capacity as a Function of Temperature (Reference 4)
- FIGURE 3 Effect of Temperature on Cranking Power Requirements for Various Grades of Oils (Reference 5)
- FIGURE 4 Espar Swingfire Heater
- FIGURE 5 Schematic of Operation of the Mixing Pipe
- FIGURE 6 Turboheater in Operation
- FIGURE 7 Hot Air Blower in Operation
- FIGURE 8 Hot Air Heating System Schematic
- FIGURE 9 Photo of Mixing Pipe, Swingfire Heater and Turboheater
- FIGURE 10 Dahl Fuel Filter/Water Separator
- FIGURE 11 Webb Fuel Heater
- FIGURE 12 Rise in Engine Temperatures During 70 Minutes of Preheating (Initial Cold Soak Temperature -8°C)

UNCLASSIFIED

UNCLASSIFIED

LIST OF FIGURES (cont'd)

FIGURE 13 Rise in Personnel Compartment Temperatures in 70 Minutes of Preheating (Initial Cold Soak Temperature -8°C)

FIGURE 14 Temperature Increases Produced During Preheating Test with Hot Air Blower (Initial Cold Soak Temperature -13°C)

FIGURE 15 Unsuccessful Start Attempt, Vehicle Cold Soaked at -16°C

FIGURE 16 Unsuccessful Start Attempt after 27 Minutes of Preheating (Initial Cold Soak Temperature -16°C)

FIGURE 17 Successful Start Attempt after 43 Minutes of Preheating (Initial Cold Soak Temperature -16°C)

UNCLASSIFIED

DEFENCE RESEARCH ESTABLISHMENT SUFFIELD
RALSTON, ALBERTA

SUFFIELD MEMORANDUM NO. 1165

IMPROVING LOW TEMPERATURE STARTABILITY OF M113 VEHICLES:
HOT AIR HEATING TESTS

by

T.F. Stupich
V.S. Shankhla
W.G. Förster

1.0 INTRODUCTION

In response to a tasking initiated by the Directorate of Combat Mobility Engineering and Maintenance, the Vehicle Mobility Section at the Defence Research Establishment Suffield conducted studies to determine the performance limitations of M113A1 armoured personnel carriers at low temperatures (down to -40°C). An additional objective undertaken as part of the tasking was to make recommendations for modifications of present machinery, systems or procedures based on evidence obtained by conducting experiments. Currently, M113 vehicles exhibit very poor cold starting capabilities and experience an extremely high incidence of component failure at low temperatures. To avoid cold starting problems, standard operating procedure is to continuously idle the M113 engine throughout the duration of deployment in cold regions.

A wealth of information regarding the poor performance of M113

UNCLASSIFIED

vehicles during Arctic exercises is contained in the maintenance report from Exercise Sovereign Viking 1981 [1]. This report identifies shortcomings of M113 vehicles with regard to cold regions operations and provides insight into the probable causes of some of the many vehicle breakdowns. Prolonged engine idling was identified as a primary cause of vehicle breakdowns. Reports from previous Arctic exercises also cite the engine's inability to attain normal operating temperature as a chief cause of breakdowns, but on Exercise Sovereign Viking 1981 the use of vehicle insulation enabled virtually normal engine operating temperatures to be reached. Various other heat retention devices such as grille covers and shutters, controlled cooling fans and exhaust retractor can also increase engine operating temperatures.

Reference 2 reports on tests designed to define the minimum reliable starting temperatures of typical in-service M113 vehicles operated by CF personnel. This study revealed the severity of the starting problem and thereby the necessity, given the current vehicle, of continuous engine idling even in moderate winter conditions.

In order to eliminate the need for continuous idling, cold starting capabilities require substantial improvement. However, there are many factors that contribute to the cold starting problems of diesel vehicles. Diesel engines operate on the principle of compression ignition; therefore, a minimum combustion chamber temperature must be achieved during the compression stroke in order for the fuel/air mixture to ignite. The compression temperature achieved is mainly dependent on air inlet temperature and attainable cranking speed. Figure 1 reveals the effect of preheating intake air from an ambient temperature of -20°C up to temperatures as warm as 20°C . At a cranking speed of 150 rpm, for instance, the effect would be to increase compression temperatures from 300°C to 370°C . This would very

likely be the difference between a successful start and a no-start (a combustion chamber temperature of 340°C ensures ignition of diesel fuel [3]).

Figure 1 also displays the effect of cranking speed on compression temperature and hence starting. A cranking speed of 120 rpm would heat -20°C intake air to only 250°C, whereas with a cranking speed of 180 rpm the air would be heated to 340°C. From another perspective, even though at 20°C a cranking speed of 120 rpm is sufficient to attain the ignition temperature of diesel fuel (shown by broken line), 180 rpm is needed at the lower temperature.

Cranking speed is chiefly dependent on available battery power and resistance to cranking. The amount of power that a battery can deliver is a function of the electrolyte temperature as shown in Figure 2. A battery at -30°C can deliver only 20% of the rated maximum power whereas one at 27°C potentially has 100% available.

Engine lubricant viscosity is the factor having the most influence upon the amount of cranking resistance encountered. Viscosity is profoundly affected by temperature as evidenced by Figure 3. Transmission lubricants can also have a significant effect on the total cranking resistance on some vehicles but M113s are equipped with the Arctic clutch, a device which disconnects the crankshaft from the transfer gearcase in order to reduce cranking resistance.

Apart from intake air temperature, electrolyte temperature and engine lubricant viscosity, the only factor having a major influence on cold starting ability is the delivery of fuel to the combustion chamber. The increased fuel viscosity and reduced cranking speeds common to low temperatures can decrease the quality of injection of the

fuel and thereby cause additional starting problems.

During this investigation of M113 low temperature startability, a total of four different concepts were tested. These were:

- a. Automatic Engine Cycling
- b. Hot Coolant Transfusion
- c. Electric Heating
- d. Heating Using Hot Air and Heater Exhaust

The tests were conducted at Canadian Forces Base Winnipeg, January - February 1984, and were performed to determine the most favourable concept for heating M113 vehicles deployed in cold regions.

This report is concerned with the performance of two hot air heating systems. In these heating systems, fuel-fired pulse combustion heaters were utilized for preheating. Preheating involves rapidly increasing the temperatures of an initially cold vehicle in order to enable starting. Both hot air and exhaust gases were used to heat batteries, the engine block, engine lubricant and intake air. Vehicle modifications were also made to facilitate the testing of fuel warming and conditioning devices, grille covers and a controlled cooling fan.

2.0 OBJECTIVES

1. To determine the feasibility of preheating M113 vehicles using hot air and heater exhaust.
2. To compare the starting ability of vehicles equipped with hot air heating systems with that of unequipped vehicles.

3. To determine the capability of the hot air heating systems tested to preheat M113 vehicles at temperatures as low as -40°C.
4. To determine the minimum temperatures to which various components must be heated in order to enable vehicle starting.
5. To determine the minimum heat input and preheating time required to enable starting as a function of initial vehicle temperature.

3.0 EQUIPMENT

3.1 Test Vehicles

M113 armoured personnel carriers equipped with 6V53 Detroit Diesel engines were utilized as test vehicles. Data on these vehicles and the 6V53 power plant are presented in Annex A. Vehicle preparations for low temperature operation involved the use of winter grade diesel fuel, 15W40 multigrade motor oil and a 45% water, 55% ethylene glycol coolant mixture. A CF issue grille cover was installed over the fan and radiator grille on each vehicle to reduce the influx of cold ambient air into the engine compartment. In addition, the fan belts on each vehicle were removed in order to decrease engine warmup time and simulate the effect of a thermostatically-controlled cooling fan. Two vehicles are of concern in the tests of the hot air heating system, the control vehicle and the test vehicle.

3.2 Data Acquisition

Both vehicles were equipped with type T thermocouples which measured oil, coolant, intake air, fuel and electrolyte temperatures (see Figure B-1). Table B-1 provides a listing for the 18

thermocouples installed on the test vehicle. A schematic drawing of their locations is shown in Figure B-2. A listing of the locations of the thermocouples installed on the control vehicle is provided in Annex D.

To permit measurement of starting current and voltage, a 1200A 50mV current shunt as shown in Figure B-3 was installed on each of the vehicles. Engine speed was measured using an optical encoder on the camshaft. Figure B-4 shows the encoder and Figure B-5 displays its installation. The encoder produced 300 pulses per revolution of the camshaft.

A Macsym 350 data acquisition system was used to record and display temperatures and starting data. Figure B-6 gives a schematic of the hardware used in this data acquisition system. Annex B also includes a copy of the software which was written in MACBASIC.

3.3 Vehicle Heating

Espar Swingfire heaters (see Figure 4) were used as the sources of heated air and hot exhaust gases. The heaters are fuelled by gasoline and produce approximately 12KW (40,000 BTU/hr) [6]. They operate on the principle of pulse combustion which means that electrical power is required only during heater start-up. Since they are also equipped with their own fuel tank, the heaters require no external connections once started and therefore are easily portable while operating. Swingfire heaters are claimed by the manufacturer to be capable of starting at temperatures as low as -54°C, and they can be used with a wide variety of heat exchangers which make the heater adaptable to many different types of heating systems.

The heat exchangers used during these tests included the mixing

pipe (Figure 5), the turboheater (Figure 6) and the hot air blower (Figure 7). The Swingfire heater outputs a pulsating stream of exhaust gases. When the mixing pipe is attached to it, fresh air is entrained into the stream of exhaust gases and the mixture is delivered at a temperature of about 340°C. The turboheater uses the exhaust stream to drive a turbine which draws air through the heat exchanger and outputs exhaust-free air at a temperature of approximately 100°C. There is a separate exhaust for the products of combustion. The hot air blower also uses a turbine to entrain fresh air but does not completely remove all products of combustion from the heater output. The hot air blower has a much higher outlet temperature (300°C) than the turboheater. Note that the output temperatures quoted above are representative of the results obtained during the tests reported herein, for which fresh air temperatures were in the range -16°C to +2°C.

As shown schematically in Figure 8, the heating system on the test vehicle utilized two Swingfire heaters, one in conjunction with a mixing pipe and the other with a turboheater. A photo of a mixing pipe, Swingfire heater and turboheater is provided in Figure 9. The rear engine access panel on the vehicle was modified to permit installation of a 6" length of 1½" flexible pipe that originated in the personnel compartment and terminated inside the engine compartment underneath the rear of the oil pan. For vehicle heating tests, the mixing pipe was coupled to this pipe and was thus able to warm the oil pan despite being located in the personnel compartment.

The second Swingfire heater was also installed in the personnel compartment, but this one was used with a turboheater for the purpose of warming vehicle batteries. Battery heating was accomplished through the use of 6" diameter flexible ducting which connected to the turboheater and directed the hot air output toward the top of the batteries. In the initial set-up, a battery lid was used to direct the

heat evenly over the top of the batteries and also to reduce the amount of heat escaping from the battery box. During the first test of this system, however, it appeared that the amount of heating was excessive and that the batteries would be damaged unless the output from the turboheater was dispersed to a greater extent. Therefore, in all subsequent tests the battery lid was not utilized. Turboheater exhaust was carried through the modified rear engine access panel and directed at the top of the right cylinder head. The limited space available within the engine compartment dictated the location at which this exhaust pipe terminated. It would have been preferable to have the exhaust directed evenly across the engine block rather than over a small area on one side of the block.

The hot air blower was used on the control vehicle but did not require vehicle modification or the permanent installation of any equipment. Heating of the control vehicle merely involved removing the air cleaner and directing the hot air blower output directly into the air intake through the use of a length of 3½" flexible ducting.

3.4 Fuel Conditioning

The test vehicle was equipped with a Dahl Model #100 fuel filter/water separator (see Figure 10). This filter was used as a replacement for the standard vehicle primary fuel filter because of superior water extraction and contaminant filtration capabilities. A Webb Fuel Heater (Figure 11) was used in conjunction with the improved filter since the two together were considered a potential solution to fuel line freezing and filter clogging problems. The fuel heater used hot coolant from the engine as its heat source. Heating of fuel decreases the size of the wax crystals in it. Fuel heating also reduces fuel viscosity, improves atomization and decreases the incidence of ice crystal formation. When the fuel filter/water

separator is used, the fuel heater is needed to reduce the size of the wax crystals because of the substantially increased degree of filtration (2 micron filter vs. 15 micron filter of standard vehicle).

4.0 TEST PROCEDURE

Vehicle temperatures were automatically measured and recorded at one minute intervals. Measurement of starting data was initiated manually whenever required; the data consisted of engine speed, starting current and starting voltage taken over a 20 second span.

Tests on the starting ability of cold soaked vehicles were conducted with both the test vehicle and the control vehicle. Cold soaked was defined as a condition where all vehicle temperatures were within a range of 4°C. Cold soak temperature is the average engine temperature of a cold soaked vehicle. Cranking periods were limited to 15 seconds. A maximum of five starting attempts were made after which a no-start was declared. The maximum of five, 15 second cranking periods is advocated in the Canadian Supplement of the M113 Operator's Manual [7].

Swingfire heaters were applied once a no-start was identified and were used to preheat cold soaked vehicles to temperatures at which starting would be possible. On the test vehicle, the first heater started was inserted into the mixing pipe, then the second heater was started and inserted into the turboheater. Once a vehicle started successfully, the heaters were switched off and removed. Vehicle warmup procedures ensued in accordance with those outlined in the M113 Operating Manual [8]. When the coolant temperature (measured at the thermostat housing) reached 60°C the engine was shut off and allowed to return to a cold soak state.

To decrease cranking resistance and thereby improve starting ability, the Arctic clutch was utilized during all starting tests. Use of the Arctic clutch is recommended by the CF for starting in the temperature range of 4°C to -32°C [8]. In addition, engine fan belts were removed to simulate having a thermostatically controlled cooling fan on the vehicle. (The concept of using a controlled cooling fan on the M113 had been approved, but appropriate hardware was unavailable at the commencement of testing.) The major benefit of controlling cooling fan operation while the vehicle is deployed in cold regions is a reduction in the cooling effect on the engine and a resultant increase in engine operating temperatures. In these tests, removal of the fan belts served to decrease the time required to reach 60°C during engine warm-up.

The specific gravity of the electrolyte in vehicle batteries was checked daily and whenever the temperature compensated value dropped below 1.25, the batteries were replaced, as recommended in the vehicle operators manual [8].

5.0 RESULTS AND DISCUSSION

Table 1 lists the type of heating tests conducted on both the test vehicle and the control vehicle. Those tests in which the vehicle started without being heated are not included in the table. The Swingfire heaters were used to heat the test vehicle on seven occasions. On four of those occasions (Test No. 3, 5, 6 and 7) ambient temperature conditions were warm enough that heating was not necessary to enable starting, but heating was carried out nevertheless in order to gather information on the effect of the heaters on vehicle temperatures. To enable starting on the control vehicle, the hot air

blower was needed only three times.

Table 2 provides startability data for an M113 vehicle as a function of cold soak temperature. Table 3 displays temperature increases produced during the initial fifteen minute segment in each of the four heating tests with the mixing pipe/turboheater combination. Table 4 displays the temperatures to which the test vehicle was heated before starting was possible.

Figures 12 and 13 display the effect of preheating with the mixing pipe/turboheater combination on engine and crew compartment temperatures. Figure 14 shows the effect of the hot air blower on vehicle temperatures. Starting data curves for unsuccessful as well as a successful start attempt are shown in Figures 15-17.

In Annex C a complete record of the temperature and starting data recorded from the test vehicle is provided. Annex D contains the data for the control vehicle.

5.1 Heater Performance

Very little comment about the results obtained in these tests can be made without first discussing the performance of the Swingfire heaters. These heaters exhibited severe reliability problems throughout the test period as revealed in Table 1. They malfunctioned during six of the seven heating tests conducted. To minimize the effect of a heater malfunction on vehicle temperatures, heaters were restarted as soon after a heater shutdown as possible. Monitoring and restarting of heaters became a full-time endeavour as, during some tests, both heaters shut down several times. On occasion a heater remained shut down for several minutes.

The Swingfire heaters also required frequent fine tuning of the fuel regulator knob which adjusted the fuel/air ratio. Typically, after approximately ten minutes of operation, the heater would start to run rough and would require adjustment. During some tests re-adjustment was performed frequently, but this appeared to increase heater operating time only slightly.

The foremost objective of these tests was to determine the practicality of the concept of heating with hot air and exhaust, while determination of the applicability of the Swingfire heaters was of secondary importance. Therefore when, prior to commencement of tests, the heaters began to exhibit cold starting problems, the decision was made to store them indoors at warm temperatures. In each test thereafter, Swingfire heaters were started indoors and were carried out to the vehicles and inserted into the heat exchangers. In spite of those precautions, heater starting was difficult and occasionally resulted in a delay of several minutes from the time that the first heater was installed in the mixing pipe and the time that the second was installed in the turboheater.

Pulse combustion heaters tend to be very noisy and Swingfire heaters are certainly no exception. Noise levels were not measured but ear protection is recommended while operating the heater within the confines of the personnel compartment. Once installed in a heat exchanger, the noise level was reduced substantially, particularly in the case of the turboheater.

A potentially serious problem exhibited by the heaters was the leaking of gasoline out the end of the combustion pipe. On a few occasions, this resulted in flames shooting out the end of the combustion pipe during start-up. This alone may be considered serious

enough to warrant disqualification of the Swingfire as a candidate for use on a vehicle.

5.2 Startability of Cold Soaked Vehicles

It was found during testing that all the vehicles on which starting tests were performed had identical low temperature starting abilities. Table 2 reveals the reduction in startability as temperature drops. Starting ability decreases with temperature until a cold soak temperature of -12°C is reached; below this temperature starting becomes impossible. It was also noted that successful starting only occurred at cranking speeds greater than 120 rpm. The startability that the M113 vehicles exhibited during these tests is examined in greater detail in Reference 9. The effect of temperature on current, voltage and cranking speed is also discussed. For instance, it was found that the current draw and voltage drop increased at lower temperatures while cranking speed was reduced. At a cold soak temperature of -17°C , the draw on the vehicle batteries was so severe that cranking characteristics began to deteriorate within seconds. On the other hand, at -12°C and above, cranking characteristics were consistent throughout all five 15 second cranking periods. At temperatures above -1°C the engine cranked at high speeds (eg. 180 rpm) and started after only a few seconds.

5.3 Vehicle Preheating

An analysis of the effect that preheating with hot air had on vehicle temperatures was difficult to perform because of the poor reliability of the Swingfire heaters. There was only one test in which the heaters operated without malfunctioning for significantly more than fifteen minutes. Therefore, a study of the variations in vehicle temperatures must be limited to short heating periods or must be based

solely on data from one test. During that test, 70 minutes of preheating were performed without any heater malfunctions.

Figure 12 displays the engine temperatures recorded in the 70 minute heating period. The greatest temperature rise occurred in the oil because the mixing pipe exhausted directly onto the oil pan. The air temperatures in the engine compartment (thermocouples 7, 8 and 9) increased substantially and remained within a few degrees of each other throughout the heating period. Coolant at the right rear cylinder head was 10°C warmer than coolant at the thermostat housing. Both the right rear cylinder head and the fuel inlet appear to receive considerable heat from the turboheater exhaust.

Immediately following shut-down of the heaters, front and rear engine compartment temperatures dropped dramatically while oil, fuel and coolant temperatures decreased at a much lower rate.

Figure 13 displays the temperature variations in the crew compartment brought about through the use of the turboheater. The temperature of the turboheater output increased quickly and then stabilized near 100°C. Air in the battery box showed the most substantial temperature rise due to the fact that turboheater output was directed at the batteries. The temperature within the battery also rose significantly but dropped abruptly when the turboheater was shut down. The bulk temperature of the electrolyte in a battery cannot actually change as quickly as the curve in Figure 13 suggests; therefore, it is apparent that the installed thermocouple did not provide a true value of the average internal battery temperature. However, by the end of the heating curve shown in Figure 13 battery temperature had levelled off at approximately 14°C. The fact that it did so suggests that temperatures throughout the battery had reached an equilibrium and that 14°C was a more accurate indication of battery

temperature than the 42°C reading recorded at the time the turboheater was shut down. The air temperature increased much more in the rear of the crew compartment than in the front because the turboheater outlet was in the rear. Soon after shutdown, front and rear converged at -2°C, which corresponds to an increase of about 8°C.

Test No. 1 in Table 3 shows mixing pipe/turboheater data from 15 minutes of preheating on a vehicle initially at a cold soak temperature of -12°C. Test No. 2 displays data gathered on the coldest day during the Swingfire test period. In this test, the initial cold soak temperature was -16°C and a total heating period of 43 minutes was required to enable starting. These two examples show very close correlation between the temperature increases produced at corresponding vehicle locations.

Tests 3 and 4 in Table 3 also show a close correlation between one another but in some aspects differ markedly from tests 1 and 2. In tests 3 and 4, oil pan temperatures were lower while the coolant in the right rear cylinder head was warmer. The air temperature at the front of the engine bay was considerably lower as well. These differences occurred as a result of vehicle starting attempts performed during the fifteen minute preheating period in tests 3 and 4. Warm oil from the sump would have been drawn up into the engine and replaced by cooler oil from the engine. The coolant in the right rear cylinder head was most likely displaced by warmer coolant circulated from the area directly beneath the turboheater exhaust outlet. Engine cranking caused a drop in engine compartment temperature because cold air was drawn in from outside the vehicle. Cranking was also found to have a significant effect on vehicle temperatures during preheating tests performed with electric heaters [9].

The only other non-uniformity between the temperature rises produced in each of the four tests was the high battery temperature achieved during test 4, but this difference was likely a consequence of a slight adjustment of the flexible ducting on the turboheater hot air outlet.

The temperature curve in Figure 14 reveals that there is virtually no similarity between preheating tests conducted on the control vehicle (hot air blower) and those conducted on the test vehicle. The air inlet, the only vehicle component to undergo any temperature rise, showed a temperature increase of 85°C in just 9 minutes of heating. Immediately after the engine was started, the air inlet temperature dropped significantly and the oil and coolant temperatures began to rise.

5.4 Starting Heated Vehicles

A frozen starter prevented test vehicle starting in one instance. None of the other vehicles used for testing had difficulties with frozen starters. The large amount of condensation within the engine compartment (droplets of water covered most components) that occurred as a result of exhaust gases being used to heat the engine was likely responsible for the problem. After cold soaking, the engine was covered in frost. To prevent this from occurring, the mixing pipe should not be employed and only the exhaust-free hot air output from the turboheater used for vehicle heating.

Table 4 displays vehicle temperatures recorded during preheating of the test vehicle. The temperatures shown are those that existed just prior to the successful start as well as those existing prior to the previous unsuccessful start attempt. A maximum of five start attempts were made during a single preheating test. Although

cold soaked vehicles could start at temperatures as low as -12°C , much warmer temperatures had to be attained in preheated vehicles. Starting was unsuccessful despite the fact that the minimum vehicle temperatures recorded at the time of each of the three unsuccessful attempts were -8°C , -6°C and -3°C respectively. In all three cases, these minimum temperatures occurred in the engine block. The average engine block temperature was increased to 0°C in two of the tests and to 2°C in the third before the engine started. The other vehicle components which have a significant effect on startability were heated to warmer temperatures as revealed by Test 2 in Table 4:

- fuel inlet = 8°C
- air inlet = 21°C
- battery electrolyte = 17°C
- engine oil = 29°C

The temperatures of these components suggests that engine block temperature was the chief factor limiting vehicle startability.

The effect of preheating on engine cranking characteristics is displayed in Figures 15-17. Figure 15 presents cranking data from the initial unsuccessful starting attempt on a vehicle cold soaked at -16°C . Initially, the voltage was approximately 24V (battery voltage) but dropped as soon as engine cranking commenced. Current and engine speed rose sharply at the same instant.

Figure 16 shows the improvement in cranking characteristics effected by 27 minutes of heating with the mixing pipe/turboheater combination. Current draw was reduced to 400A from 600A, voltage dropped to 14.5V as opposed to 12.5V, and the engine was on the verge of starting due to an increase in cranking speed from 90 rpm to 140 rpm. The rise in engine speed to nearly 600 rpm at the beginning

of the cranking period (caused by the engine firing briefly) is a clear indication that the starting attempt was almost successful.

Figure 17 shows data from the successful start which occurred after an additional 16 minutes of heating. Following engine starting, the current dropped and remained well below zero, thereby indicating that the batteries had been drained substantially by the numerous unsuccessful start attempts and were being recharged at a high rate. The voltage rose to approximately 28V (regulator voltage). The engine speed fluctuated rapidly immediately after starting but began to level off at 750-800 rpm by the end of the 20 second period shown in the figure.

Large fluctuations in engine speed were caused by hunting of the governor. As cold soak temperatures decreased, governor hunting became more likely and would result in greater engine speed fluctuations. It would also continue for longer periods of time.

Although not discernable from these figures, a preheated engine would run rough for about the first minute after it was started. The CF vehicle technicians on hand claimed that the noise and vibration produced were a result of some cylinders not firing. This condition, which was likely very detrimental to the engine, was caused by the fact that the turboheater exhaust warmed only a limited area of the engine block while other areas remained at much lower temperatures. Within one minute of starting, all cylinders were firing and the engine was running smoothly, thereby suggesting that the amount of heat generated by the engine during this period was sufficient to warm the remaining cylinders.

Preheating with the hot air blower produced results that were significantly different from those obtained using the mixing

pipe/turboheater combination. The hot air blower enabled starting after a much shorter period of heating, even though, as shown in Figure 14, all vehicle temperatures except the air inlet were below -12°C . It would appear therefore that application of the hot air blower is an efficient method of heating a cold soaked vehicle. However, this method would likely encounter problems or even be completely ineffective at lower temperatures. To prevent excessive engine wear during starting at very low temperatures, the oil and the engine block should not be allowed to remain at cold soak temperatures. There are severe consequences if an engine is started and operated while the oil in the sump is in a highly viscous, gelled state.

There were two tests with the hot air blower in which the engine apparently started but then shut down immediately upon removal of the heater duct from the air inlet. This reveals that even after having started, the engine was too cold to run on its own.

5.5 Required Heat Input

The amount of heat needed to enable starting can only be estimated roughly from the data gathered in the heating tests. In the temperature range at which tests were conducted, there was no requirement for battery heating. According to Reference 10, as long as proper winter lubricants are used, a battery at -15°C has sufficient power to adequately crank an M113 engine. In the Swingfire heating tests, therefore, battery temperature was not the cause of the starting problems. With that in mind, battery heating with the turboheater was not necessary and the amount of heat utilized for that purpose should not be included in the calculation of the total amount of heat used to start the vehicle. On the other hand, turboheater exhaust, since it was ducted into the engine compartment, should be included. That, in addition to the mixing pipe output to the engine compartment brings the

total heat input to the engine to approximately 16 kW. The output from the hot air blower was about 9 kW.

At an ambient temperature of -13°C , the mixing pipe/turboheater combination was applied for 41 minutes (total energy input of 11 kWh), while the hot air blower needed only 9 minutes (total energy input of 1.4 kWh) to enable starting. The hot air blower method is obviously much more efficient. However, there is a limited temperature range over which it will be effective. The mixing pipe/turboheater method, though extremely inefficient, may be applicable over a wider range of temperatures.

To be acceptable, a preheating system must possess the capability to enable vehicle starting under the worst possible ambient condition which, in this case, was considered to be -40°C . Due to the ambient conditions which persisted throughout the test period, preheating tests could only be conducted at cold soak temperatures ranging from -12°C to -16°C . Extrapolation of the data from this range to -40°C will not produce a reliable and accurate result, but the effort is made in order to acquire a very rough approximation.

When the mixing pipe/turboheater method is applied, starting is limited by the temperature of the engine, which, as determined from the data presented in Table 4, must reach an average temperature of 0°C to enable starting. Test No. 2 in Table 4 displays data from the preheating test at -16°C , the lowest temperature at which a test was conducted. A 43 minute heating period, or 11 kWh heat input, was needed to increase the average engine temperature by 16°C and thereby permit vehicle starting. Assuming that engine temperature would continue to increase linearly with time as it did in Figure 13 and that a 40°C rise would be sufficient at an ambient temperature of -40°C , the heat requirement would be 29 kWh (110 minutes of heater application).

The Swingfire heaters never once operated unremittingly for nearly that long a period, and continuous monitoring and restarting of heaters while ambient temperatures are at -40°C are not considered practical.

6.0 CONCLUSIONS

- (1) Both of the hot air heating systems discussed herein (hot air blower and mixing pipe-turboheater combination) proved capable of enabling M113 vehicle starting at -16°C ; the hot air blower method was much more efficient and required a much shorter heating period.
- (2) Without a vehicle heating system, starting was not possible at temperatures below -12°C . Neither did it occur when the engine was cranked at less than 120 rpm.
- (3) The test results suggest that preheating at much lower temperatures would be possible using the mixing pipe/turboheater combination. The hot air blower on the other hand, appears to be limited to moderate temperatures.
- (4) The large amount of condensation that occurs within the engine compartment when using exhaust gases to heat the engine is a significant problem.
- (5) The Swingfire heaters were very unreliable. In addition, the use of gasoline for fuel would cause a logistics problem on a diesel vehicle. The heaters are dangerous since they leaked fuel and occasionally shot flames out the end of the combustion pipe. They exhibited poor cold weather starting characteristics, and they were also very noisy.

(6) The required preheating periods using the mixing pipe/turboheater combination were extremely long considering that the vehicles were cold soaked at temperatures which were only slightly below the start temperature of an unheated vehicle. Substantially more time would be required to enable starting of a vehicle cold soaked at -40°C ; the data obtained in these tests are insufficient to determine a reliable estimate or even whether it would be possible. Further testing would be required to determine a reliable estimate of the time needed, but due to the number of shortcomings of this heating system, additional work is not recommended.

REFERENCES

1. Aubry, Major, J.R., "Review of Sovereign Viking 8101 Post Exercise Report", September 1981. UNCLASSIFIED.
2. Stupich, T.F. and Shankhla, V.S., "Cold Starting Ability of In-Service M113 Vehicles (U)", Defence Research Establishment Suffield Report No. 430, November 1986. UNCLASSIFIED.
3. Englin, B.A., "Primenize Zhidkikh Topliv Pri Nizkikh Temperaturakh", ("The Use of Liquid Fuels at Low Temperatures"), M. Khimaya, 1980.
4. Engineering Technical Data Department, "Engineering Bulletin #38 Cold Weather Operation of Detroit Diesel Engines", Detroit Diesel Allison, June 1971.
5. Pettit, C.W. and Cameron, G.L., "Cranking Motor Requirements", SAE Journal 660012, 1966.
6. McGowan, R.P., "Vehicle Winterization Kits with Intermittent Combustion Heaters", U.S. Army Land Warfare Laboratory, Aberdeen Proving Ground, February 1974. UNCLASSIFIED.
7. Canadian Forces Technical Manual, C-30-570-000/MB-V02 (DGOS-104), "Canadian Supplement to TM 9-2300-257-10". RESTRICTED.
8. Department of the Army (U.S.) Technical Manual TM 9-2300-257-10, "Operators Manual M113A1", August 1978. UNCLASSIFIED.

9. Stupich, T.F., Shankla, V.S. and Förster, W.G., "Improving Low Temperature Startability of M113 Vehicles: Electric Heating Tests (U)", Defence Research Establishment Suffield Memorandum No. 1144, March 1986. UNCLASSIFIED.
10. Webster, G.D. et. al, "The Low Temperature Chamber Testing of the Compression Ignition Engine and System of the Armoured Personnel Carrier (APC) M113A1 (U)", DREO Technical Note No. 80-26, June 1981. UNCLASSIFIED.

UNCLASSIFIED

TEST NO.	AMBIENT TEMPERATURE	TYPE OF TEST	COMMENTS
TEST VEHICLE			
1	- 12°C	34 minute preheat to start	numerous heater malfunctions
2	- 16°C	43 minute preheat to start	numerous heater malfunctions
3	- 8°C	70 minute preheat	no-start due to frozen starter
4	- 13°C	41 minute preheat to start	numerous heater malfunctions
5	- 6°C	191 minute heating curve	numerous heater malfunctions — turboheater breakdown — used for only 83 minutes
6	2°C	195 minute heating curve	numerous heater malfunctions
7	- 2°C	131 minute heating curve	numerous heater malfunctions
CONTROL VEHICLE			
1	- 13°C	10 minute preheat to start	data measurement system malfunction
2	- 13°C	9 minute preheat to start	
3	- 11°C	3 minute preheat to start	

Table 1: TESTS CONDUCTED USING HOT AIR HEATING SYSTEMS

UNCLASSIFIED

UNCLASSIFIED

DATE	TEMPERATURES (°C)						APPROXIMATE AVERAGE CRANKING SPEED (rpm)	STARTABILITY
05/02/84	- 22	- 23	- 24	- 25	- 25	- 23	20	No-start
06/02/84	- 19	- 19	- 18	- 18	- 16	- 9	50	No-start
07/02/84	- 17	- 17	- 17	- 18	- 13	- 16	70	No-start
27/01/84	- 16	- 16	- 15	- 16	- 17	- 15	80	No-start
30/01/84	- 14	- 14	- 14	- 15	- 16	- 14	110	No-start
27/01/84	- 13	- 14	- 15	- 15	- 18	- 17	120	No-start
04/02/84	- 13	- 14	- 14	- 14	- 11	- 14	110	No-start
30/01/84	- 13	- 12	- 12	- 12	- 13	- 10	N/A	No-start
08/02/84	- 12	- 12	- 12	- 13	- 11	- 12	150	Start — 5th crank
25/01/84	- 12	- 12	- 12	- 12	- 8	- 10	120	No-start
28/01/84	- 9	- 9	- 9	- 9	- 8	- 12	120	Start — 3rd crank
29/01/84	- 8	- 8	- 9	- 9	- 12	- 12	140	Start — 3rd crank
26/01/84	- 8	- 8	- 9	- 8	- 10	- 8	140	Start — 4th crank
09/02/84	- 6	- 7	- 9	- 9	- 10	- 8	150	Start — 3rd crank
29/01/84	- 7	- 6	- 8	- 8	- 10	- 12	120	Start — 1st crank
31/01/84	- 8	- 7	- 6	- 7	- 7	- 3	130	Start — 3rd crank
26/01/84	- 6	- 6	- 7	- 6	- 10	- 8	140	Start — 3rd crank
10/02/84	- 7	- 5	- 5	- 5	- 4	- 3	150	Start — 2nd crank
01/02/84	- 3	- 4	- 4	- 4	- 4	- 3	150	Start — 2nd crank
12/02/84	- 2	- 2	- 2	- 2	- 3	- 3	N/A	Start — 1st crank
11/02/84	- 1	- 1	- 2	- 2	- 2	- 2	180	Start — 1st crank
24/01/84	- 1	- 1	- 1	- 1	- 4	- 1	190	Start — 1st crank

UNCLASSIFIED

Table 2: VEHICLE STARTING WITHOUT HEATING

UNCLASSIFIED

TEST NO.		TEMPERATURES °C																
		DESCRIPTION																
		OIL - OIL PAN, FRONT	OIL - OIL PAN, REAR	COOLANT - THERMOSTAT HOUSING	COOLANT - CONNECTOR PIPE	COOLANT - BLOCK, RIGHT	COOLANT - RIGHT CYLINDER HEAD, REAR	ENGINE COMPARTMENT - FRONT	ENGINE COMPARTMENT - REAR	AIR INLET	FUEL INLET	ELECTROLYTE	BATTERY BOX	CREW COMPARTMENT - FRONT	CREW COMPARTMENT - REAR	MIXING PIPE OUTPUT	TURBOHEATER OUTPUT	TURBOHEATER EXHAUST
1	Initial Temp	-11	-12	-10	-11	-11	-11	-10	-10	-11	-11	-11	-11	-12	-10	*	-12	-12
	Temp after 15 min heating	5	20	-4	-7	-6	21	17	8	0	9	47	30	2	*	81	*	*
	Temp increase	16	32	6	4	4	31	27	18	11	20	58	42	12	*	93	*	*
2	Initial Temp	-15	-16	-15	-16	-15	-15	-16	-15	-16	-15	-16	-15	-15	-15	*	-16	-17
	Temp after 15 min heating	0	13	-9	-11	-12	16	8	0	-5	4	39	25	-3	*	87	*	*
	Temp increase	15	29	6	5	4	31	24	15	11	19	55	40	12	*	103	*	*
3	Initial Temp	-8	-8	-8	-8	-9	-9	-10	-9	-9	-8	-9	-10	-10	*	-10	-11	-11
	Temp after 15 min heating	1	13	-4	-5	5	12	15	10	1	15	58	35	-1	*	93	*	*
	Temp increase	9	21	4	3	14	21	25	19	10	23	67	45	9	*	103	*	*
4	Initial Temp	-12	-13	-13	-12	-13	-12	-13	-12	-13	-11	-11	-12	-12	*	-12	-13	-13
	Temp after 15 min heating	-2	18	-8	-9	-2	8	8	-2	-5	24	50	31	4	*	88	*	*
	Temp increase	10	31	5	3	11	20	21	10	8	35	61	43	16	*	100	*	*

Table 3: EFFECT OF 15 MINUTES OF HEATING ON VEHICLE TEMPERATURE

UNCLASSIFIED

UNCLASSIFIED

TEST NO.		TEMPERATURES °C																		
		DESCRIPTION	OIL - OIL PAN, FRONT	OIL - OIL PAN, REAR	COOLANT - THERMOSTAT HOUSING	COOLANT - CONNECTOR PIPE	COOLANT - BLOCK, RIGHT	COOLANT - RIGHT CYLINDER HEAD, REAR	ENGINE COMPARTMENT - FRONT	ENGINE COMPARTMENT - REAR	AIR INLET	FUEL INLET	ELECTROLYTE	BATTERY BOX	CREW COMPARTMENT - FRONT	CREW COMPARTMENT - REAR	MIXING PIPE OUTPUT	TURBOHEATER OUTPUT	TURBOHEATER EXHAUST	AMBIENT
1		Unsuccessful start attempt (heating time = 32 minutes)	15	45	4	-2	-3	-2	30	26	14	4	24	61	42	14	*	*	*	-15
		Successful start (heating time = 33 minutes)	15	39	4	-2	-3	1	29	26	17	8	25	62	42	12	*	*	*	-15
2		Unsuccessful start attempt (heating time = 27 minutes)	6	29	-4	-6	-8	-5	17	15	10	0	13	49	33	1	*	95	*	-15
		Successful start (heating time = 43 minutes)	14	43	1	-3	-3	5	20	18	21	8	17	53	35	0	*	97	*	-15
3		Unsuccessful start attempt (heating time = 25 minutes)	4	23	-4	-5	-6	2	13	13	11	1	42	60	38	14	*	95	*	-11
		Successful start (heating time = 41 minutes)	13	37	0	-2	-2	11	13	14	19	8	45	42	22	16	*	*	*	-11

UNCLASSIFIED

Table 4: VEHICLE TEMPERATURES CORRESPONDING TO SUCCESSFUL AND UNSUCCESSFUL ENGINE STARTING

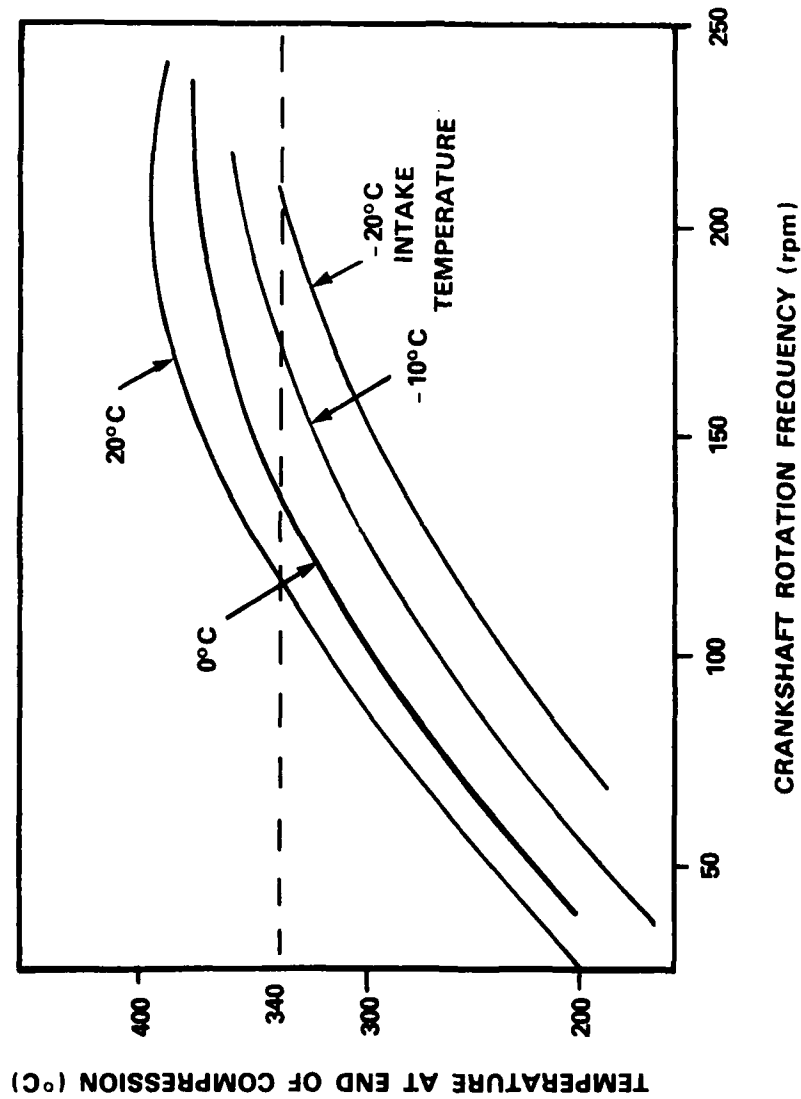


Figure 1

EFFECT OF CRANKING SPEED AND INTAKE AIR TEMPERATURE
ON COMPRESSION TEMPERATURE (Reference 3)

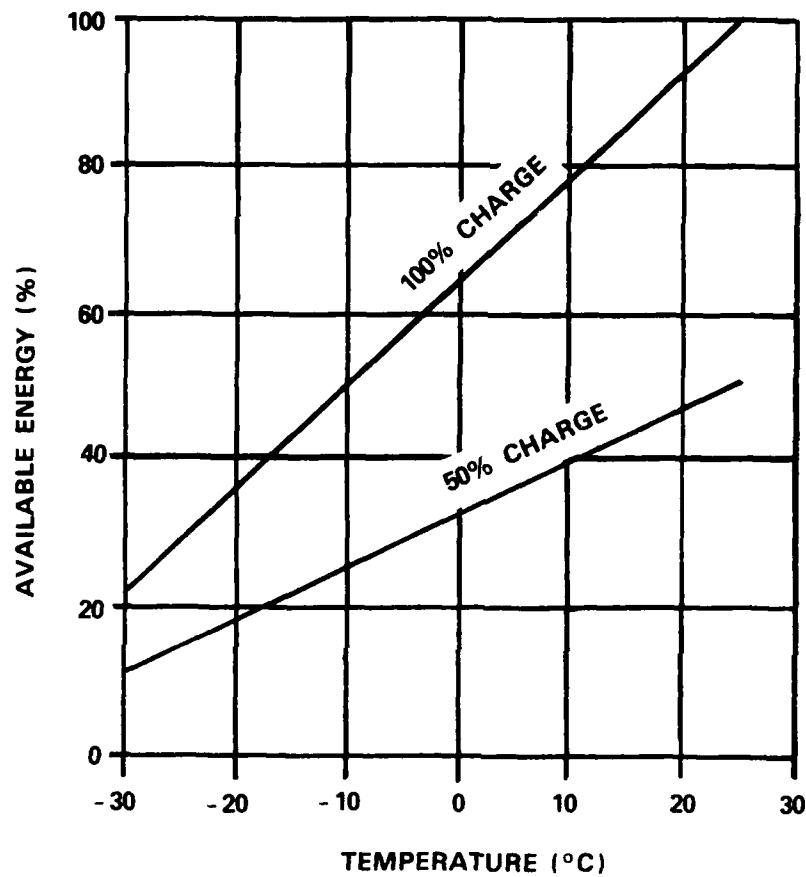


Figure 2
BATTERY CAPACITY AS A FUNCTION OF TEMPERATURE
(Reference 4)

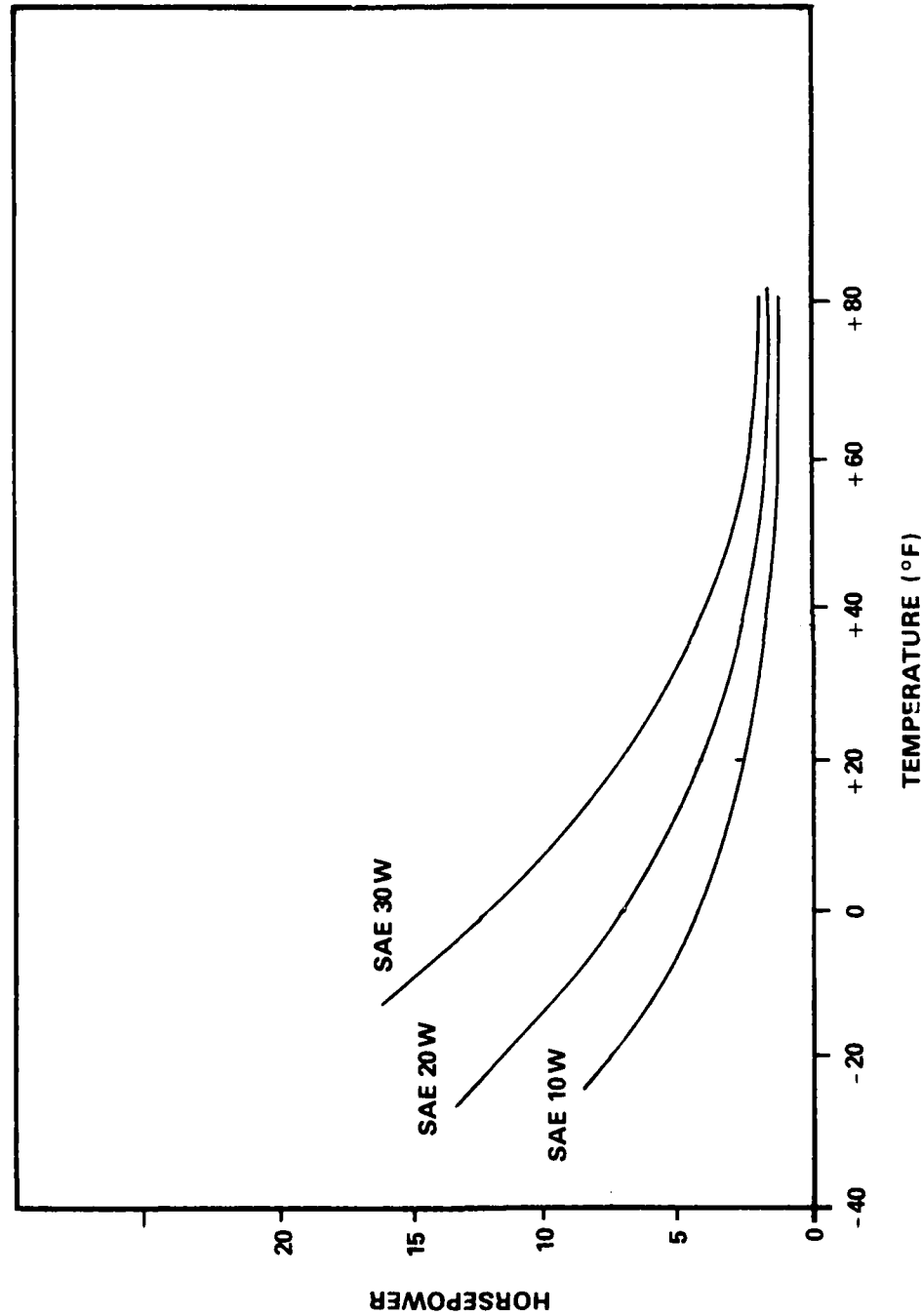
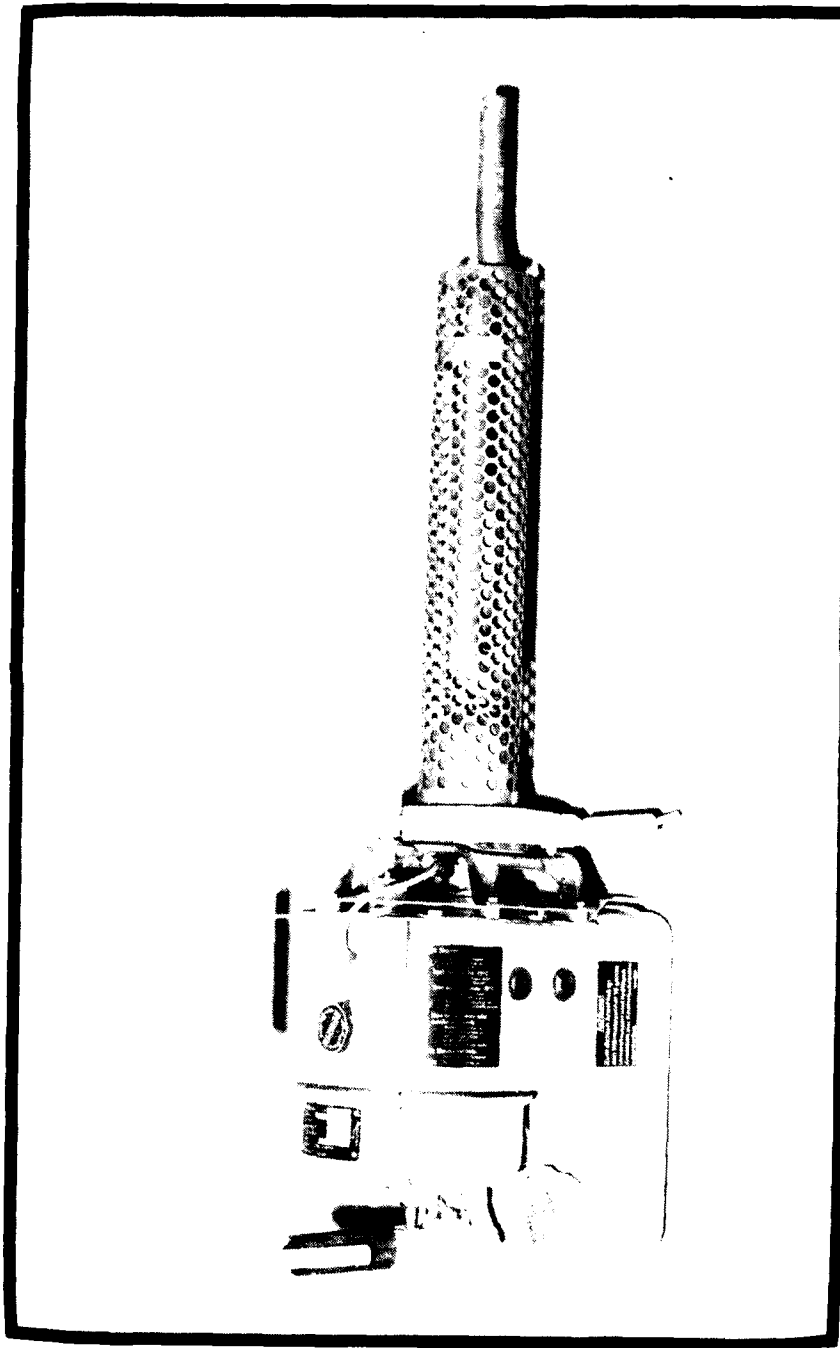


Figure 3
EFFECT OF TEMPERATURE ON CRANKING POWER REQUIREMENTS FOR
VARIOUS GRADES OF OILS (Reference 5)



85-206

Figure 4
ESPAR SWINGFIRE HEATER

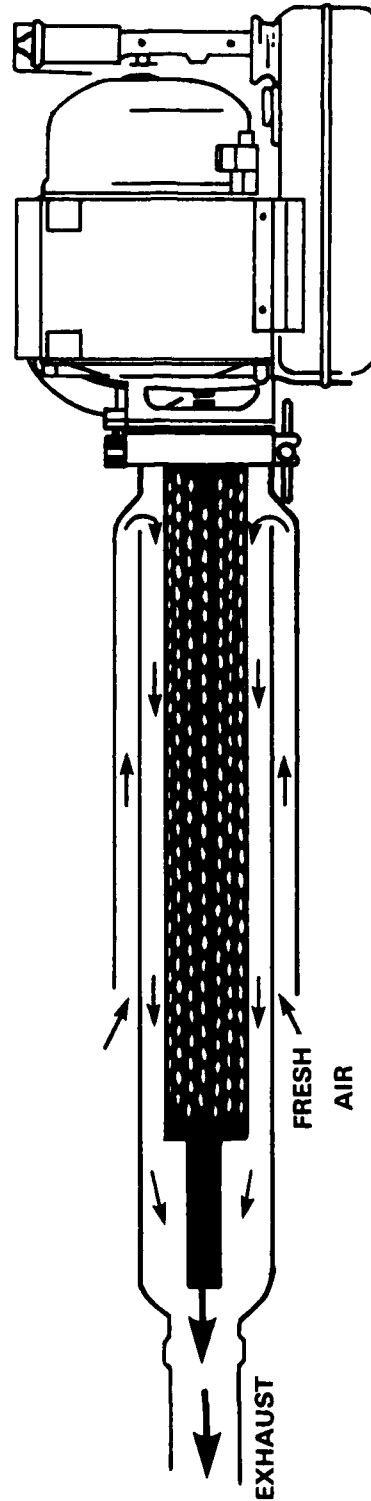


Figure 5
SCHEMATIC OF OPERATION OF THE MIXING PIPE

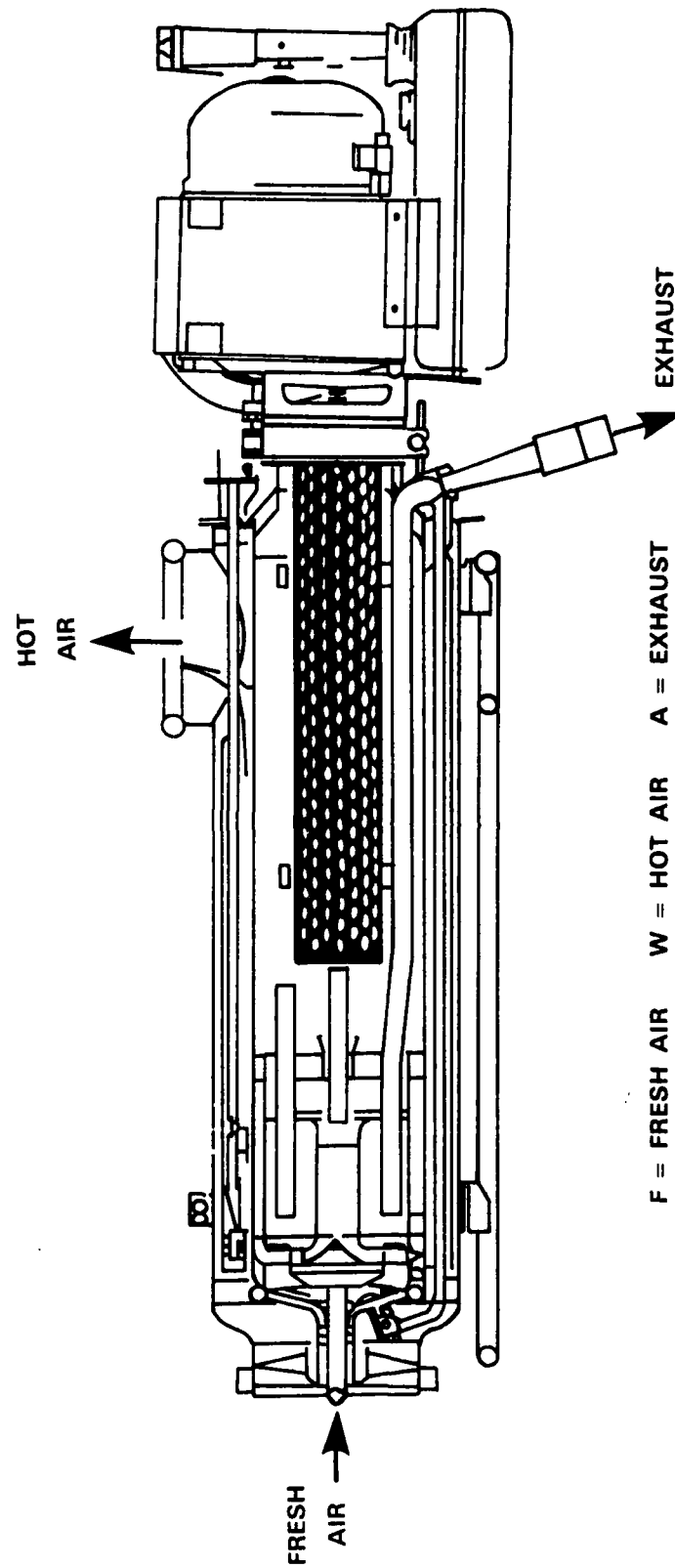


Figure 6
TURBOHEATER IN OPERATION

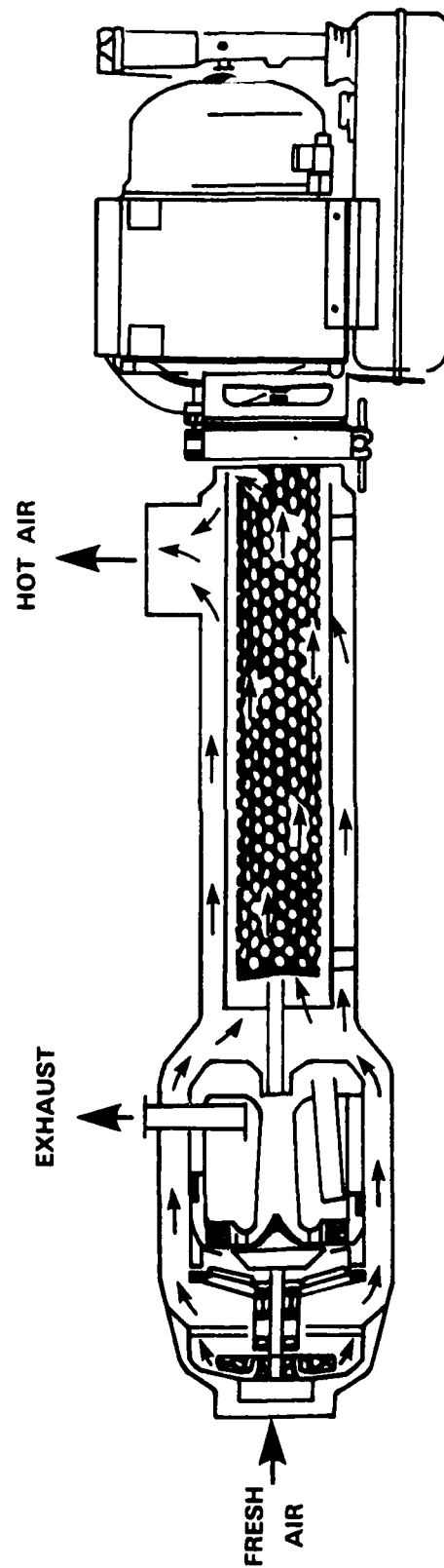


Figure 7
HOT AIR BLOWER IN OPERATION

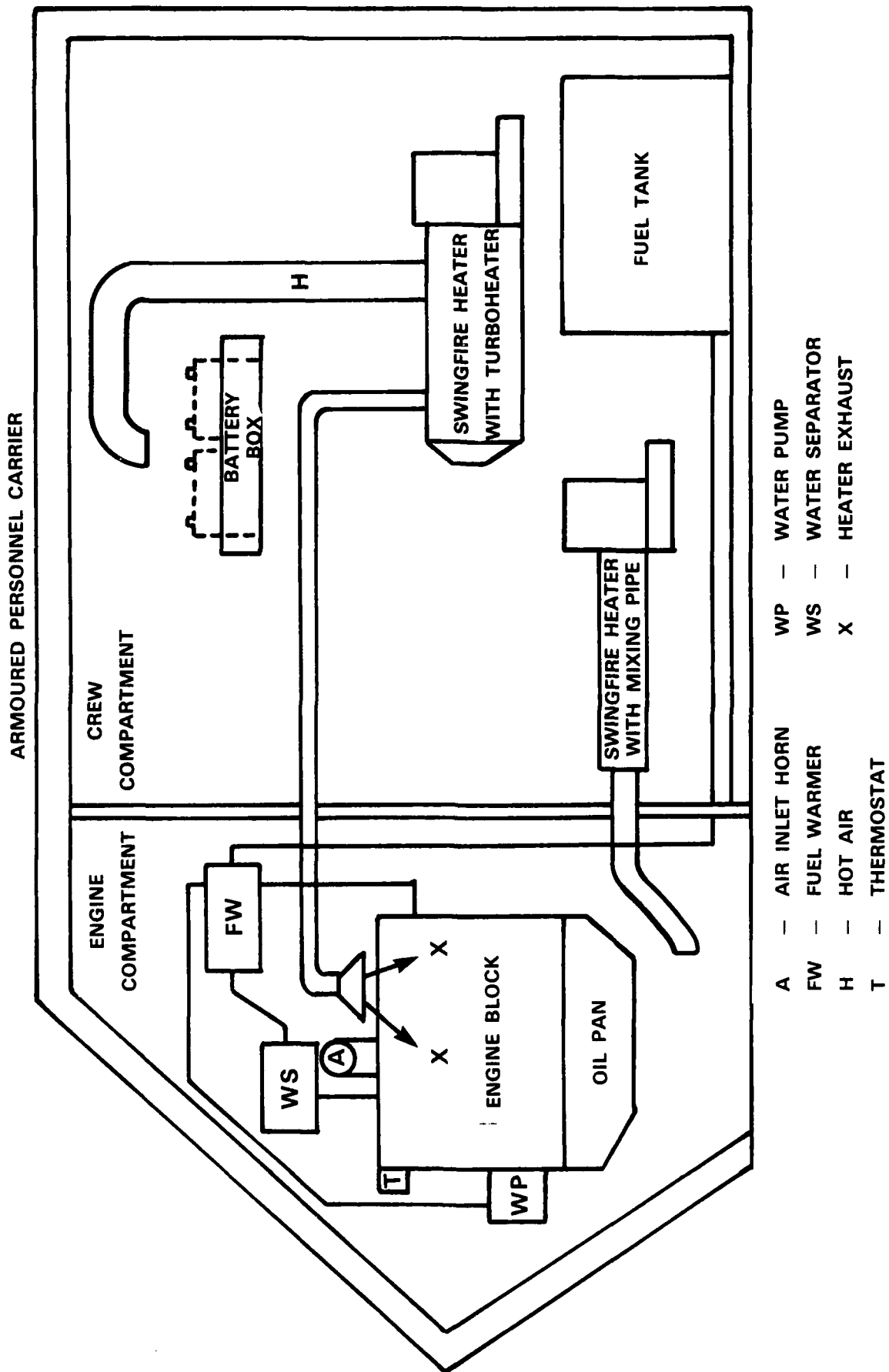
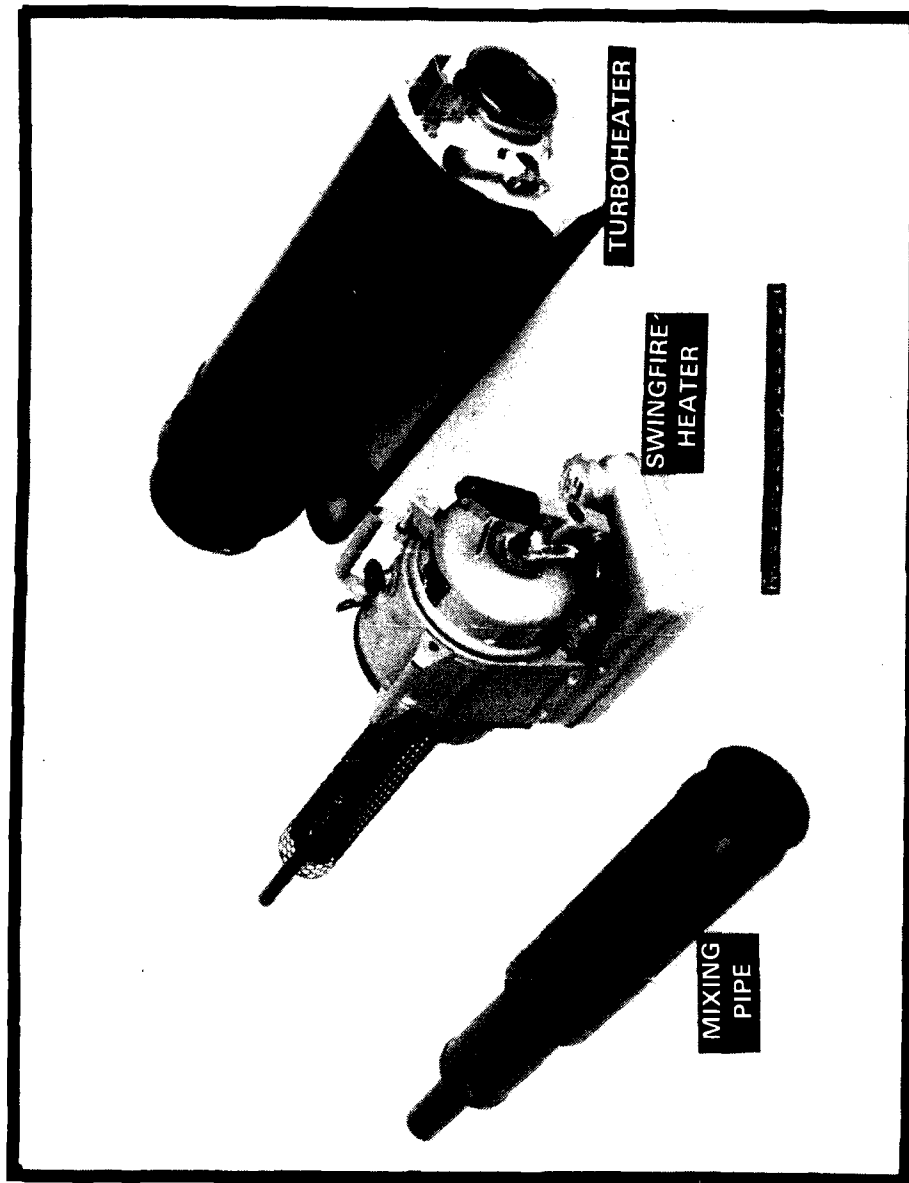


Figure 8

HOT AIR HEATING SYSTEM SCHEMATIC



83-2340

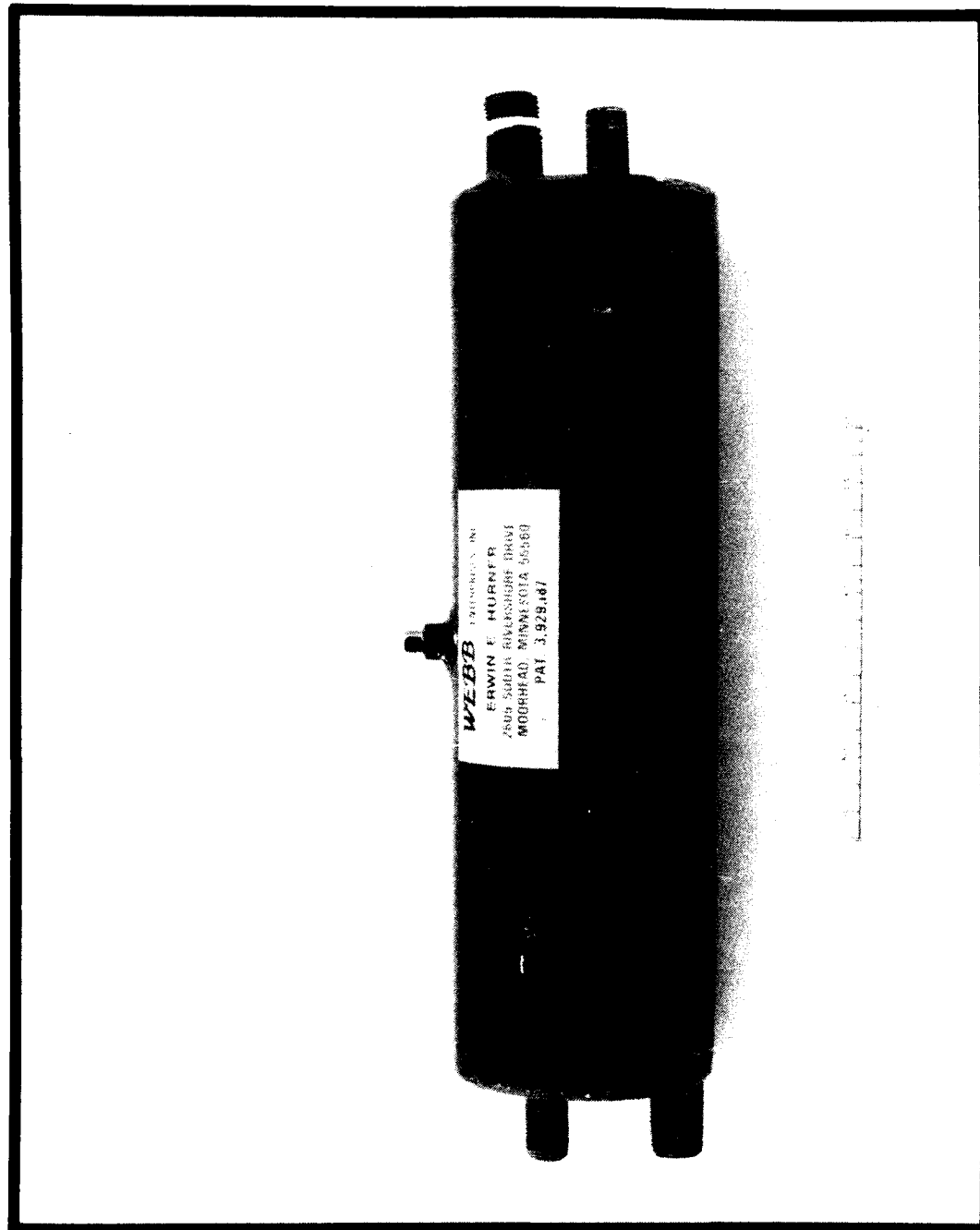
Figure 9

PHOTO OF MIXING PIPE, SWINGFIRE HEATER AND TURBOHEATER



94-68

Figure 10
DAHL FUEL FILTER/WATER SEPARATOR

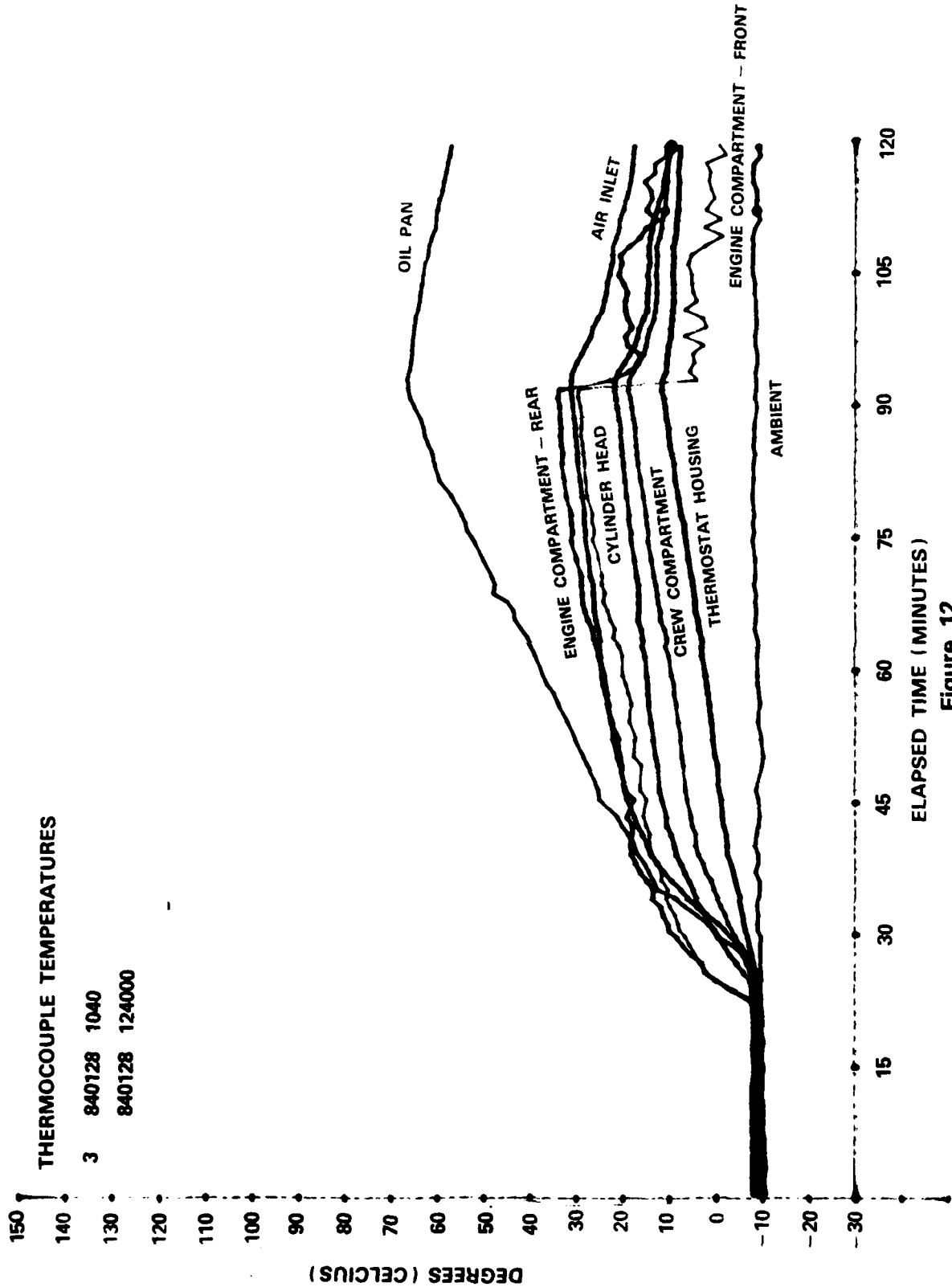


84-68

Figure 11
WEBB FUEL HEATER

UNCLASSIFIED

SM 1165



RISE IN ENGINE TEMPERATURES DURING 70 MINUTES OF PREHEATING
(Initial Cold Soak Temperature -8°C)

UNCLASSIFIED

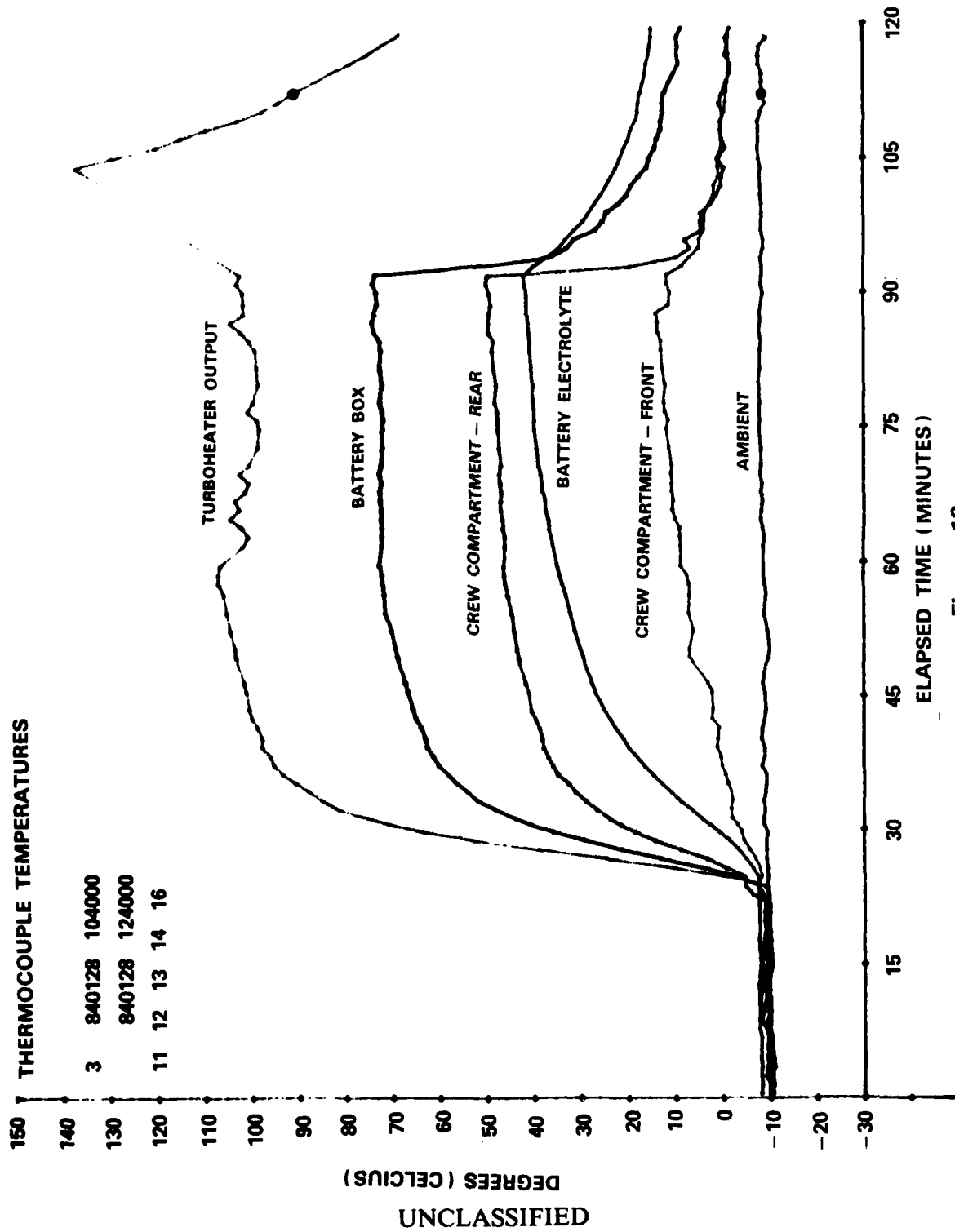


Figure 13

RISE IN PERSONNEL COMPARTMENT TEMPERATURES DURING 70 MINUTES
OF PREHEATING (Initial Cold Soak Temperature -8°C)

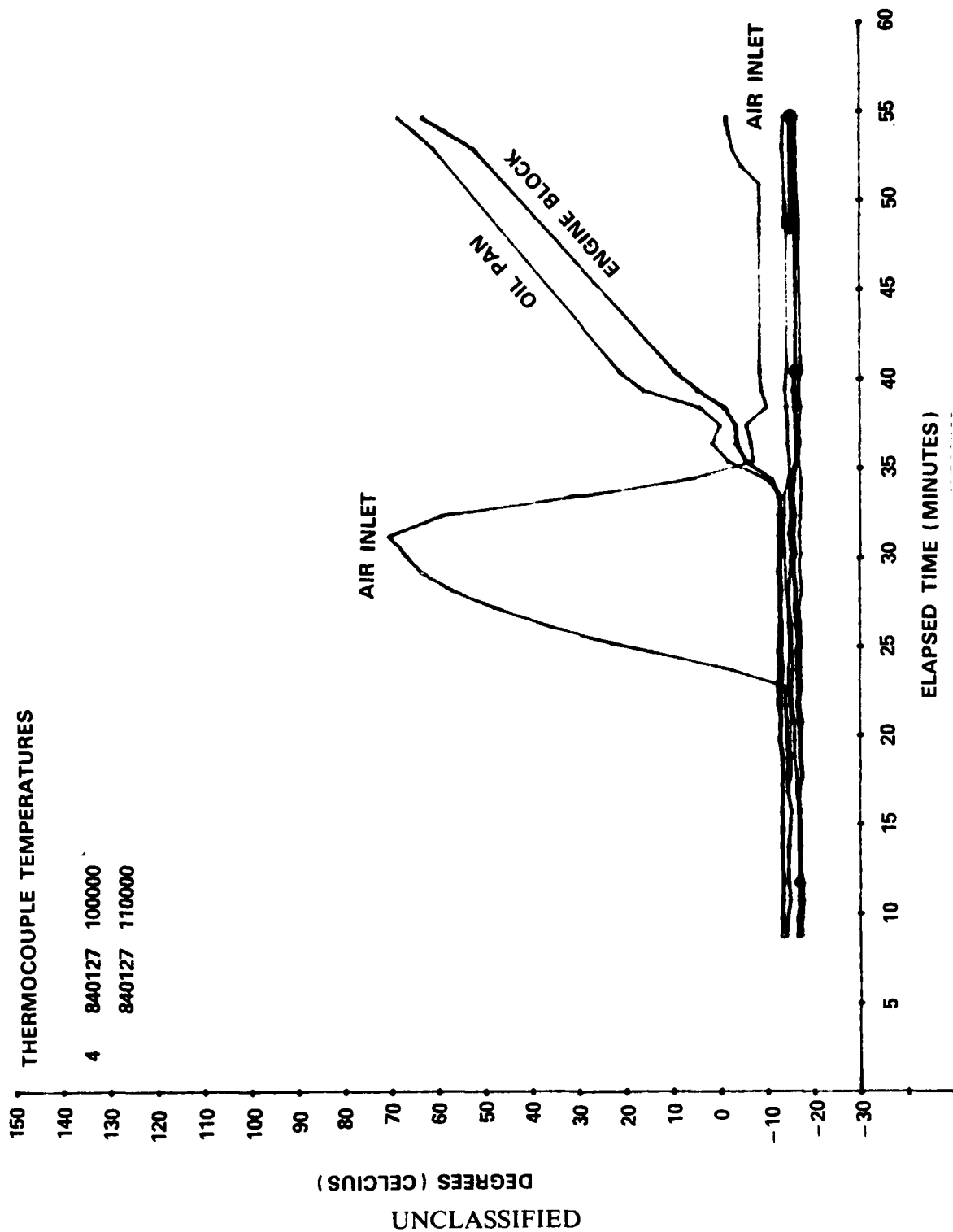


Figure 14

TEMPERATURE INCREASES PRODUCED DURING PREHEATING TEST WITH
HOT AIR BLOWER (Initial Cold Soak Temperature -13°C)

UNCLASSIFIED

SM 1165

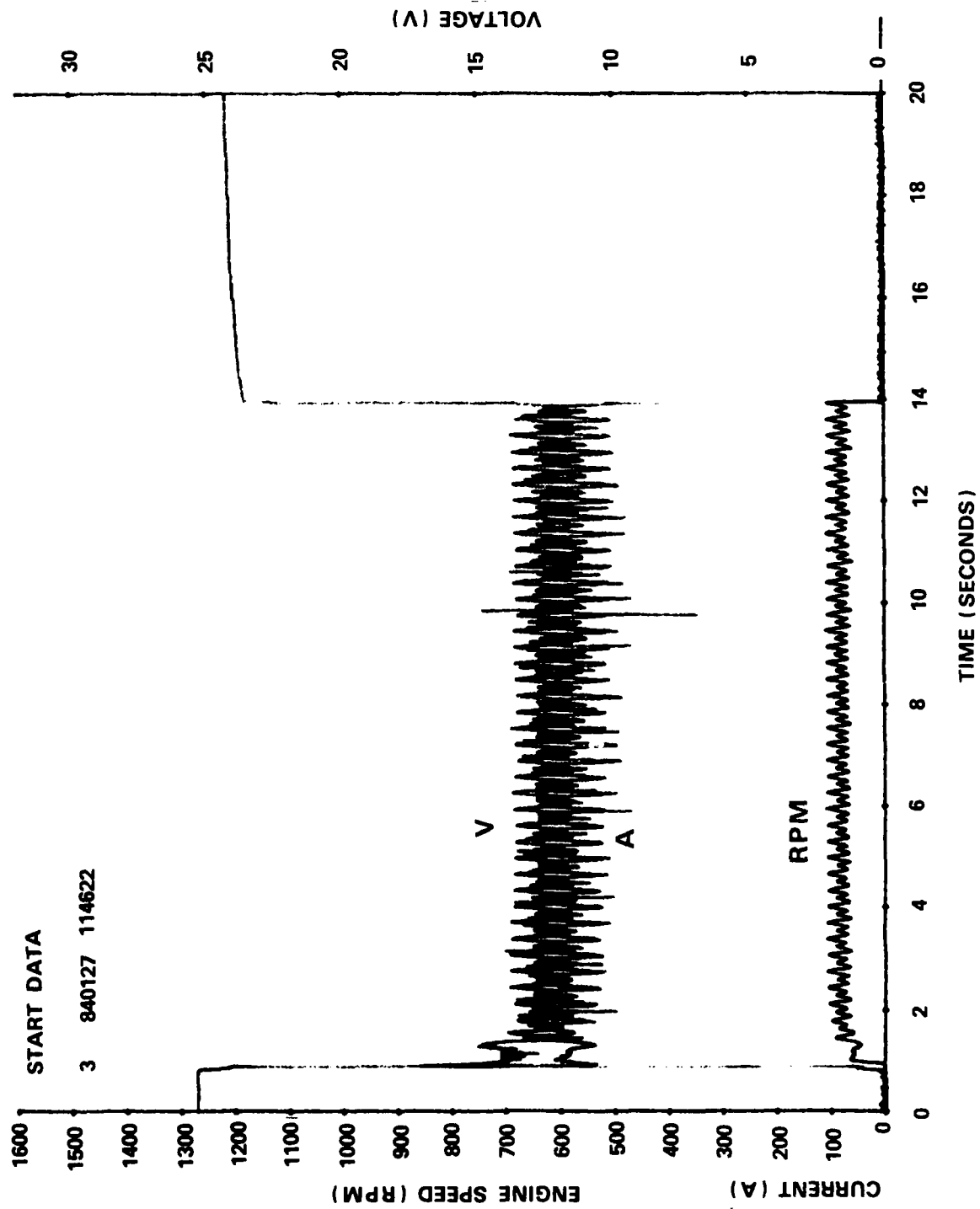


Figure 15

UNSUCCESSFUL START ATTEMPT, VEHICLE COLD SOAKED AT -16°C

UNCLASSIFIED

UNCLASSIFIED

SM 1165

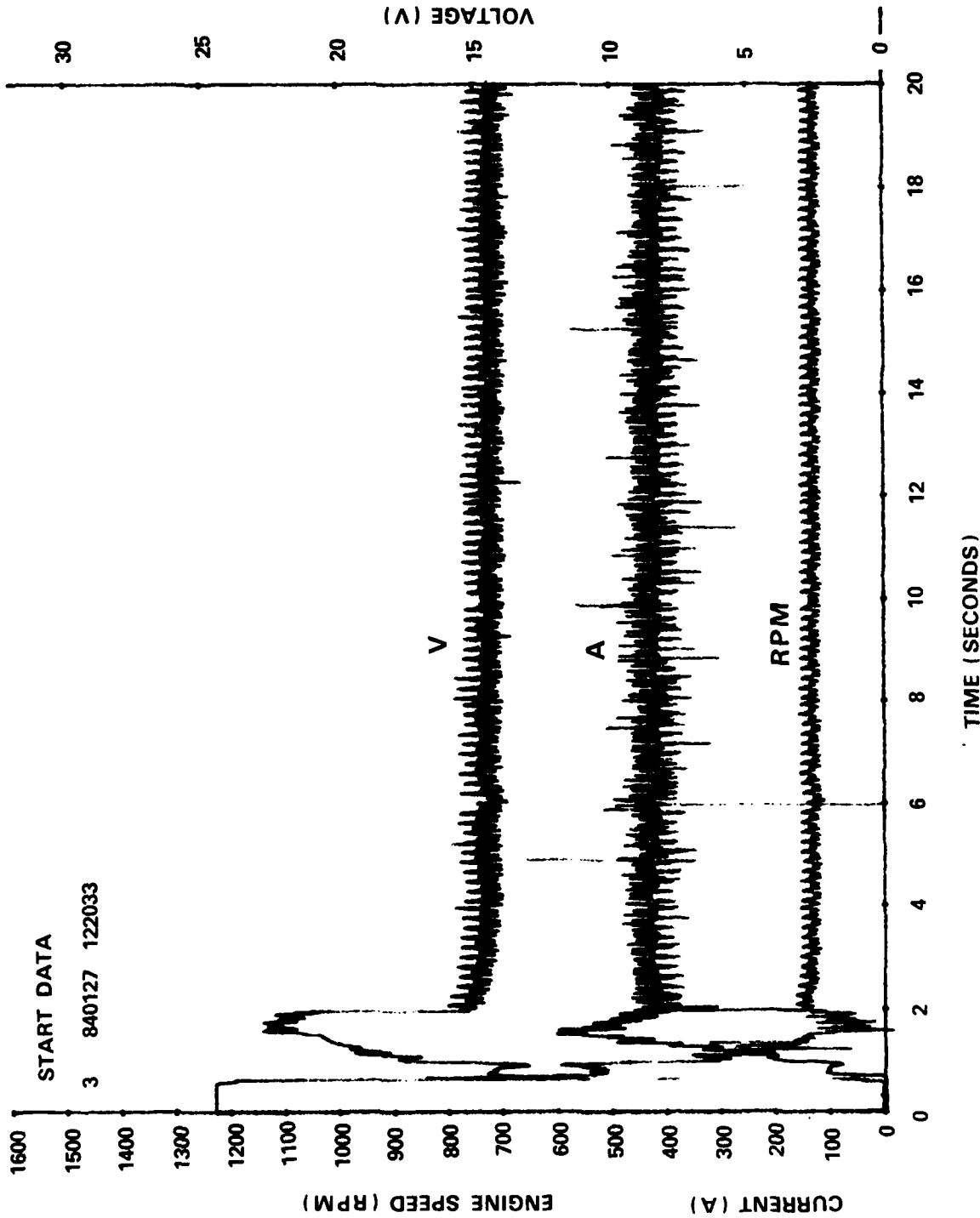


Figure 16

UNSUCCESSFUL START ATTEMPT AFTER 27 MIN OF PREHEATING
(Initial Cold Soak Temperature -16°C)

UNCLASSIFIED

UNCLASSIFIED

SM 1165

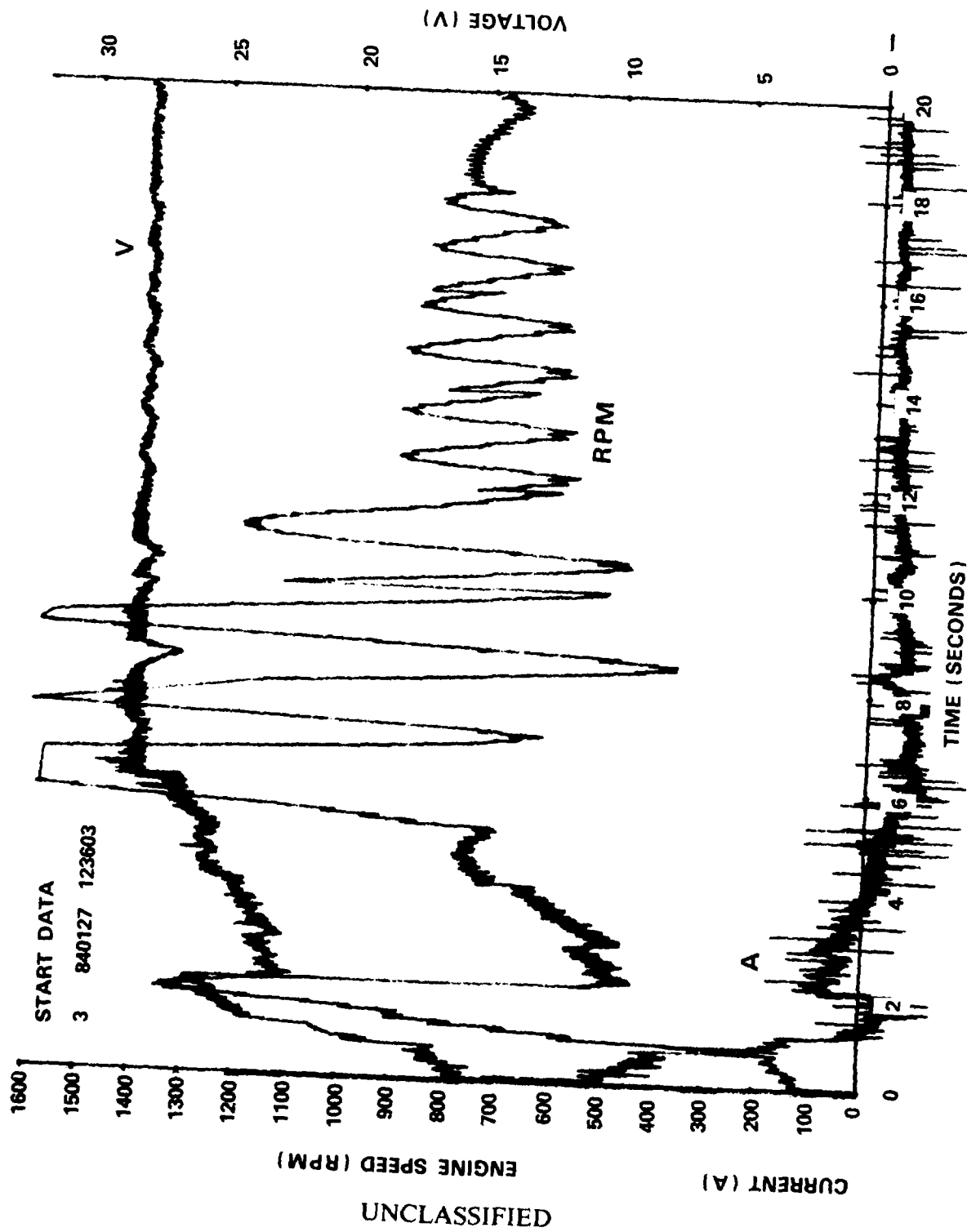


Figure 17

SUCCESSFUL START ATTEMPT AFTER 43 MIN OF PREHEATING
(Initial Cold Soak Temperature -16°C)

UNCLASSIFIED

ANNEX A
DATA SUMMARY
M113A1 APC

UNCLASSIFIED

DATA SUMMARY

M113A1 ARMoured PERSONNEL CARRIER**MANUFACTURER** FMC Corporation Ordnance Division**CAPACITY**

Crew 1 driver, 1 vehicle commander (fully equipped)

Passengers 9 personnel (fully equipped)

WEIGHT

Combat Loaded Weight 10,930 kg

DIMENSIONS

Length — maximum, overall 4,860 mm

Width — maximum, overall 2,690 mm

Height — maximum, to top of machine gun pintle 2,200 mm

Ground Clearance 410 mm

PERFORMANCE

Maximum Speed Forward 69 km/h

Maximum Speed Reverse 15 km/h

Cruising Range (at 40 km/h average speed) 430 km

Fuel Consumption (at 40 km/h average speed) 83 1/100 km

ENGINE

Manufacturer Detroit Diesel Division of GMC

Series 6V53

Model 5063 - 5299

ENGINE (Cont'd)

Type Two cycle diesel compression ignition
Firing Order (viewed from front of engine) 1L-3R-3L-2R-2L-1R
Bore 98 mm
Stroke 114 mm
Piston Displacement 5.2 L
Compression Ratio 21.5 to 1
Brake Horsepower 157 kW at 2800 rpm
Maximum Torque 670 Nm at 1300 rpm
Governed Speed — full load 2800 rpm
 — no load 2925 — 3025 rpm
Idle Speed 600 to 650 rpm
Crankshaft Rotation (viewed from front of engine) cw
Valves (4 exhaust valves per cylinder) overhead rocker arm
Dry Weight 610 kg
Normal Operating Temperature 77° — 88° C
Cooling liquid cooled w/fan and radiator
Lubrication forced feed

ELECTRICAL SYSTEM

Voltage 24 volt system
Batteries — number used (BB 248/U) 2
 — voltage 12 V
 — capacity 100 amp hour
 — ground terminal negative
Generator w/built-in rectifier
 — make Leece - Neville
 — model 2184 AC
 — capacity 100 amp
Regulator — make Leece - Neville
 — type 3392 - R12P
Starting motor — make Delco - Remy
 — model 1113873

FUEL SYSTEM

Fuel Pump — make GM
 — type — positive displacement gear type
 Fuel Line (restricted fitting) 0.075 coded R.075
 Fuel Filters (type) cartridge
 Injectors — type (limited multi-fuel) M50

TRANSMISSION

Manufacturer Allison
 Model TX100-1
 Rating — maximum input torque 440 Nm
 — maximum input speed 4000 rpm
 — maximum net input power 150 kW
 Maximum Oil Temperature 150°C
 Torque Converter Model TC-350, stall torque ratio 3.1:1
 Transmission Ratios
 — 1st gear 3.81:1
 — 2nd gear 1.94:1
 — 3rd gear 1.00:1
 — reverse 4.35:1

CAPACITIES

	<u>Refill</u>	<u>Dry</u>
Engine Oil System	17 L	20 L
Transmission Oil System	15 L	17 L
Differential Oil System	18 L	23 L
Transfer Gearcase	2 L	2 L
Final Drive	1.4 L	1.4 L
Ramp Hydraulic Sump	1.7 L	1.7 L
Cooling Fan Gear Box	0.3 L	0.3 L
Fuel Tank	360 L	
Cooling System	34 L	34 L

UNCLASSIFIED

ANNEX B
DATA ACQUISITION

UNCLASSIFIED

THERMOCOUPLE NUMBER	MEDIUM MEASURED	THERMOCOUPLE LOCATION
1	Oil	Oil pan, front
2	Oil	Oil pan, rear
3	Coolant	Thermostat housing
4	Coolant	Connector pipe, Oil cooler to engine block
5	Coolant	Engine block, right
6	Coolant	Cylinder head, rear, right
7	Air	Engine compartment, front
8	Air	Engine compartment, rear
9	Air	Air inlet horn
10	Fuel	Fuel inlet
11	Electrolyte	Battery, forward
12	Air	Battery box
13	Air	Crew compartment, front
14	Air	Crew compartment, rear
15	Exhaust Gas	Mixing pipe outlet
16	Air	Turboheater output
17	Exhaust Gas	Turboheater exhaust
18	Air	Outside of vehicle

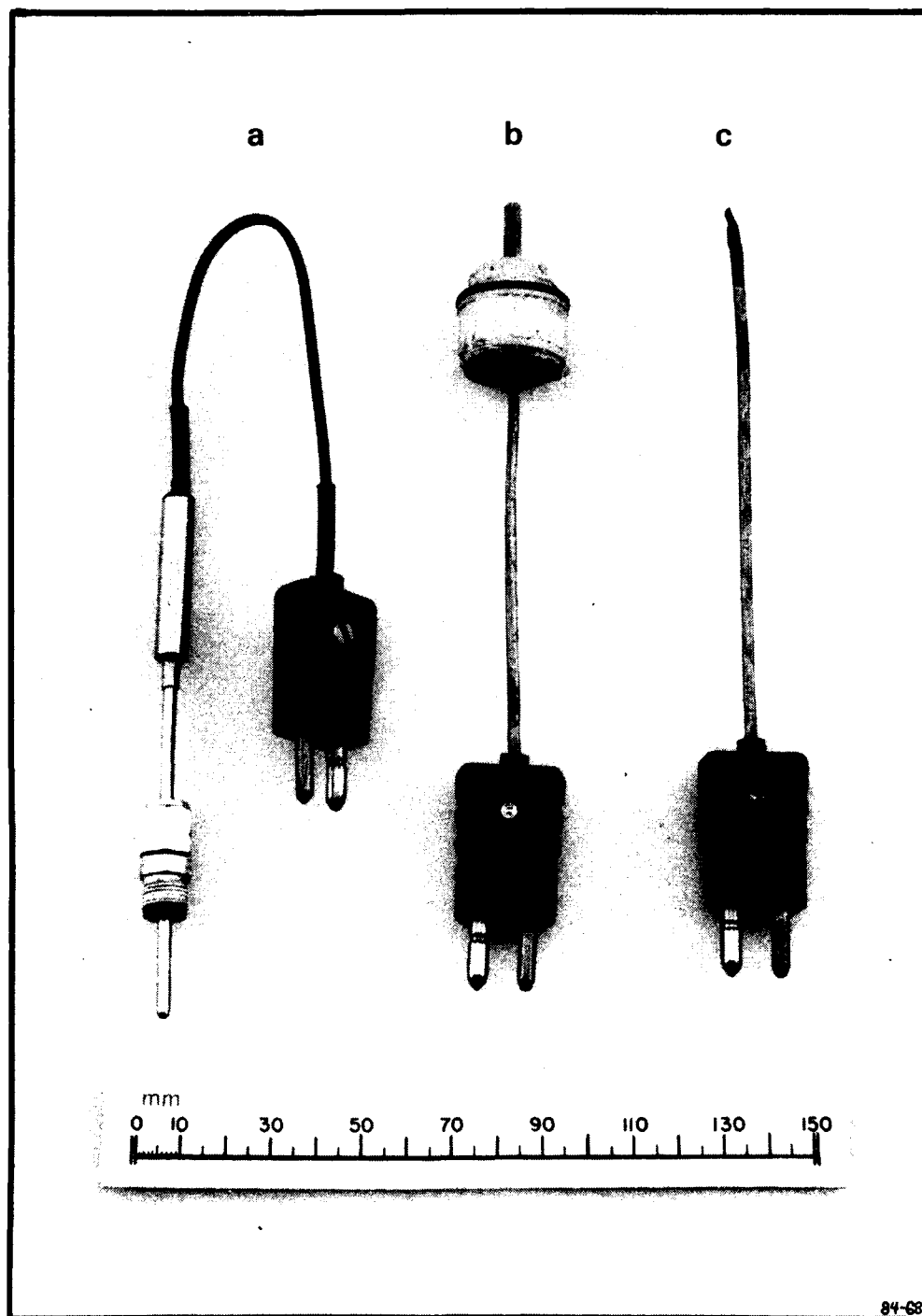
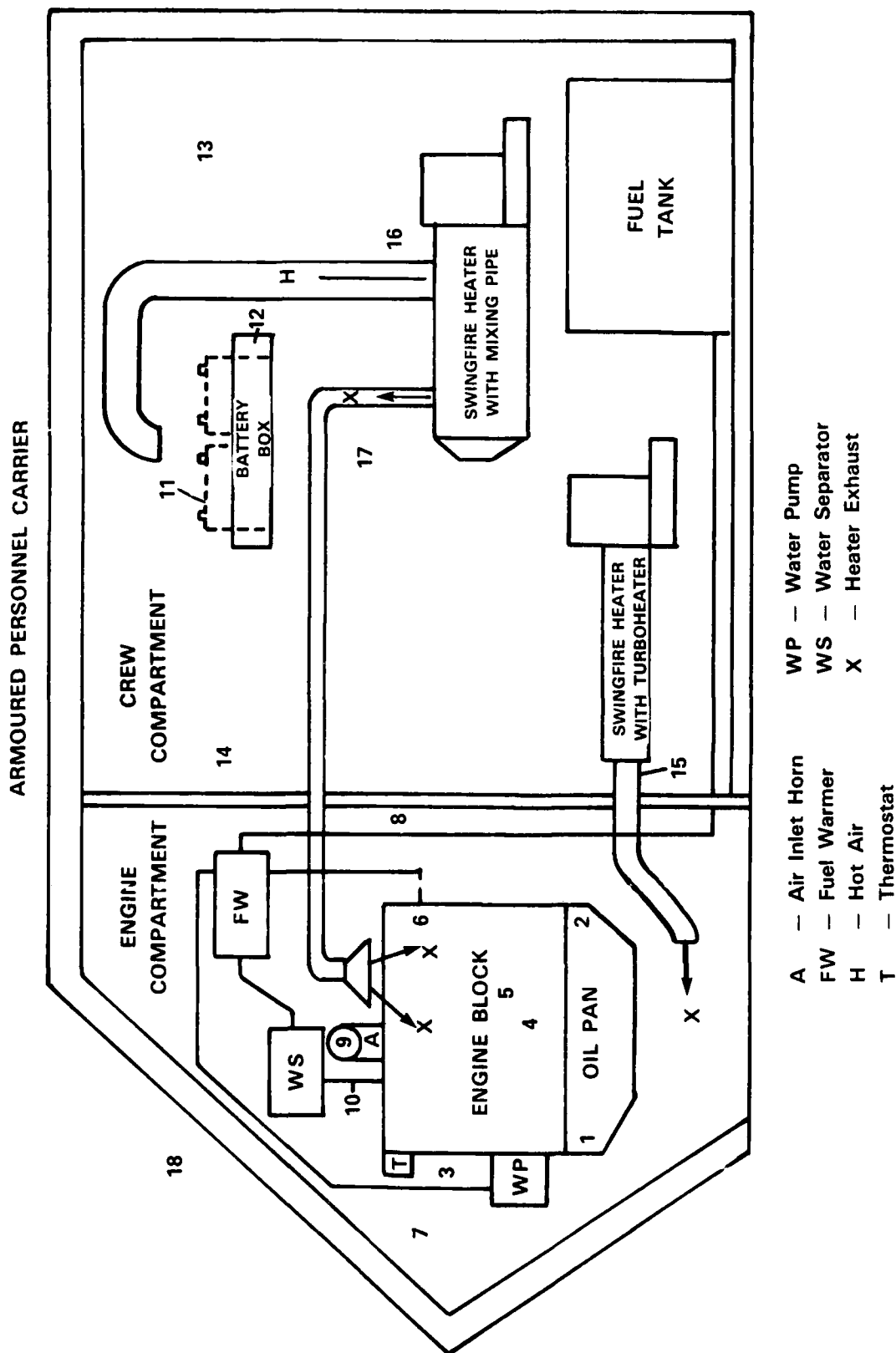


Figure B-1

EXAMPLES OF THERMOCOUPLES USED IN DIFFERENT MEDIUMS

- a) COOLANT, OIL, FUEL
- b) ELECTROLYTE
- c) AIR



UNCLASSIFIED

/B-5

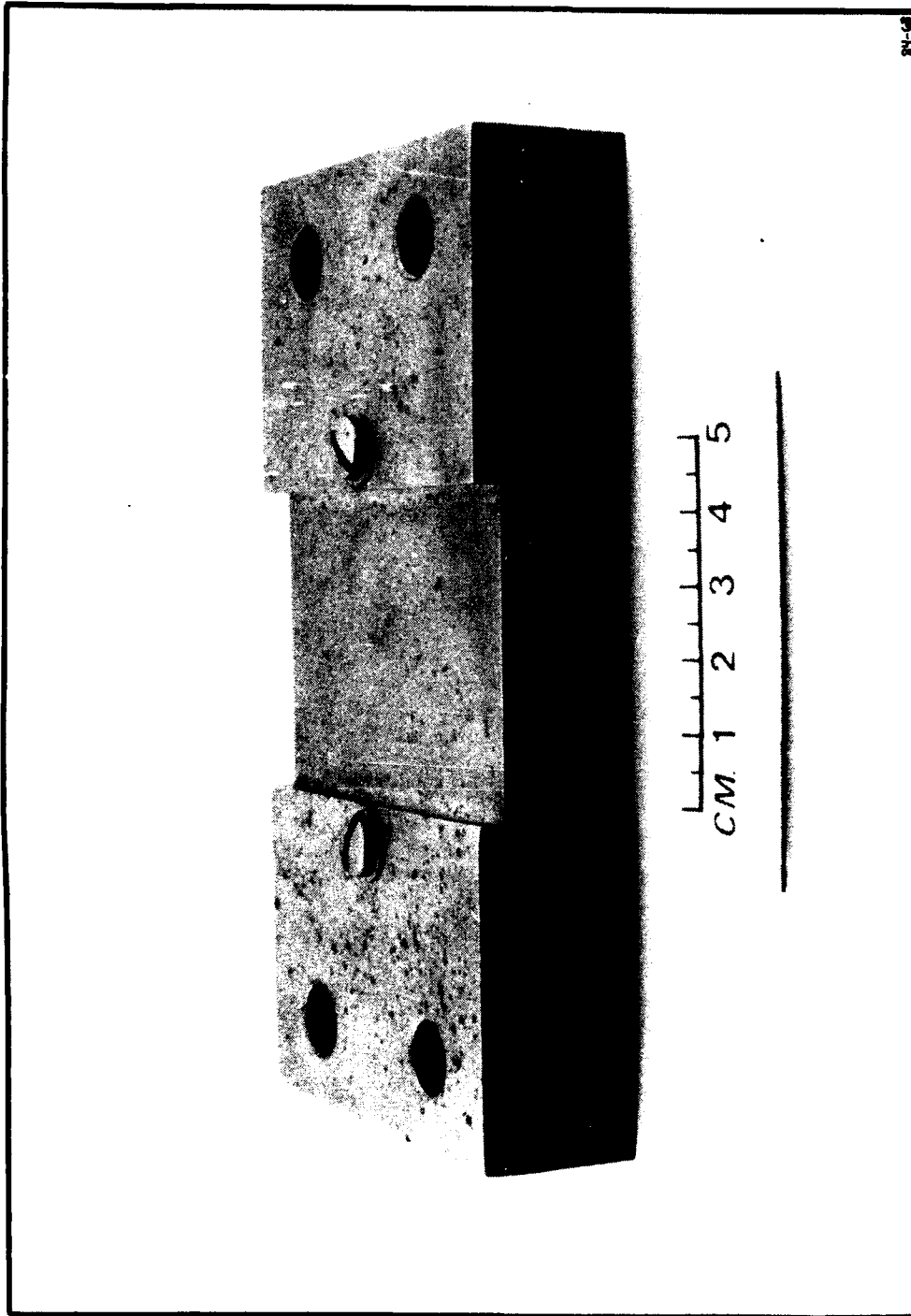


Figure B-3

CURRENT SHUNT 1200 A - 50 mV

UNCLASSIFIED

UNCLASSIFIED

/B-6

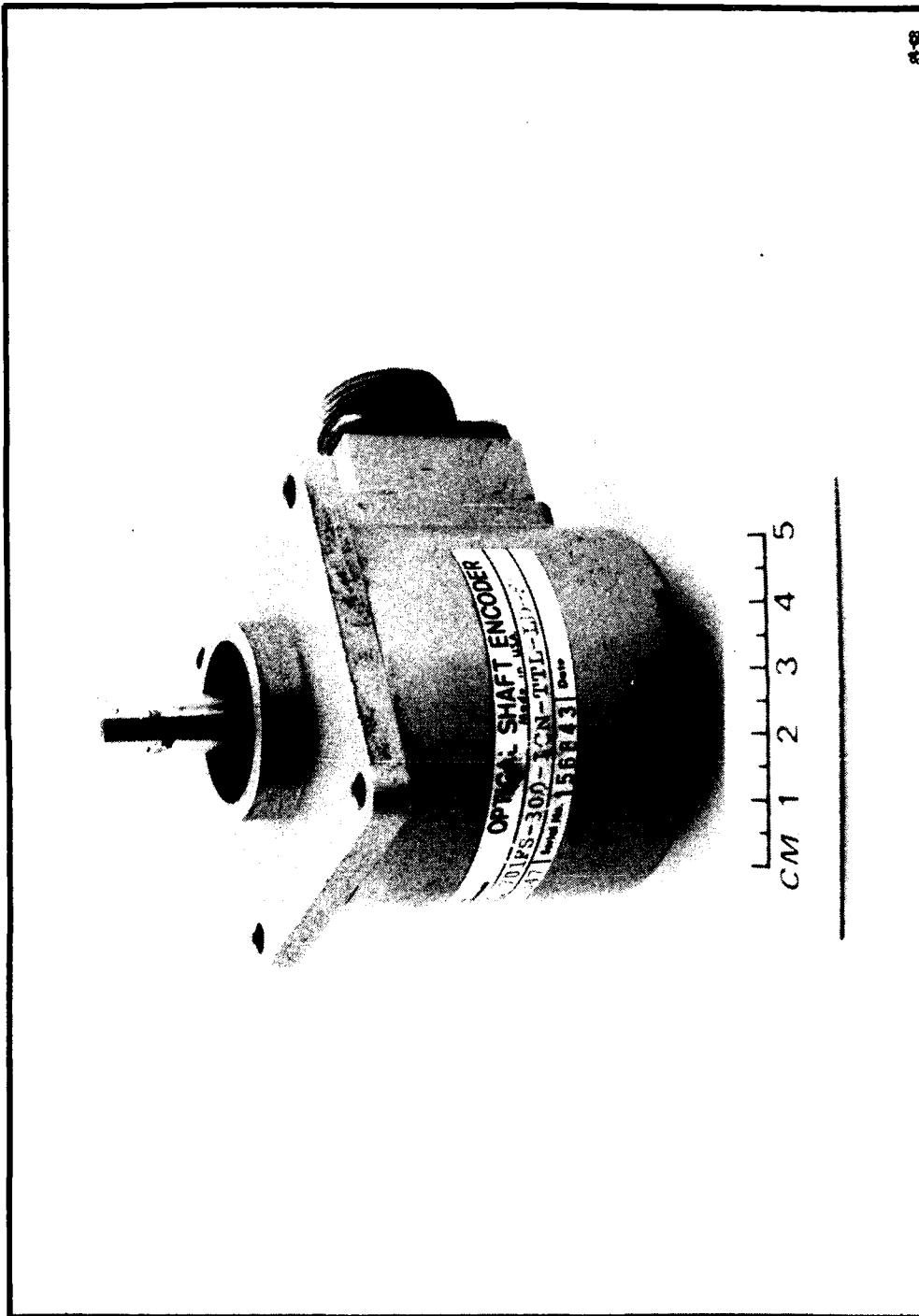


Figure B-4
OPTICAL ENCODER

UNCLASSIFIED



Figure B-5
OPTICAL ENCODER INSTALLATION

MACSYM 350

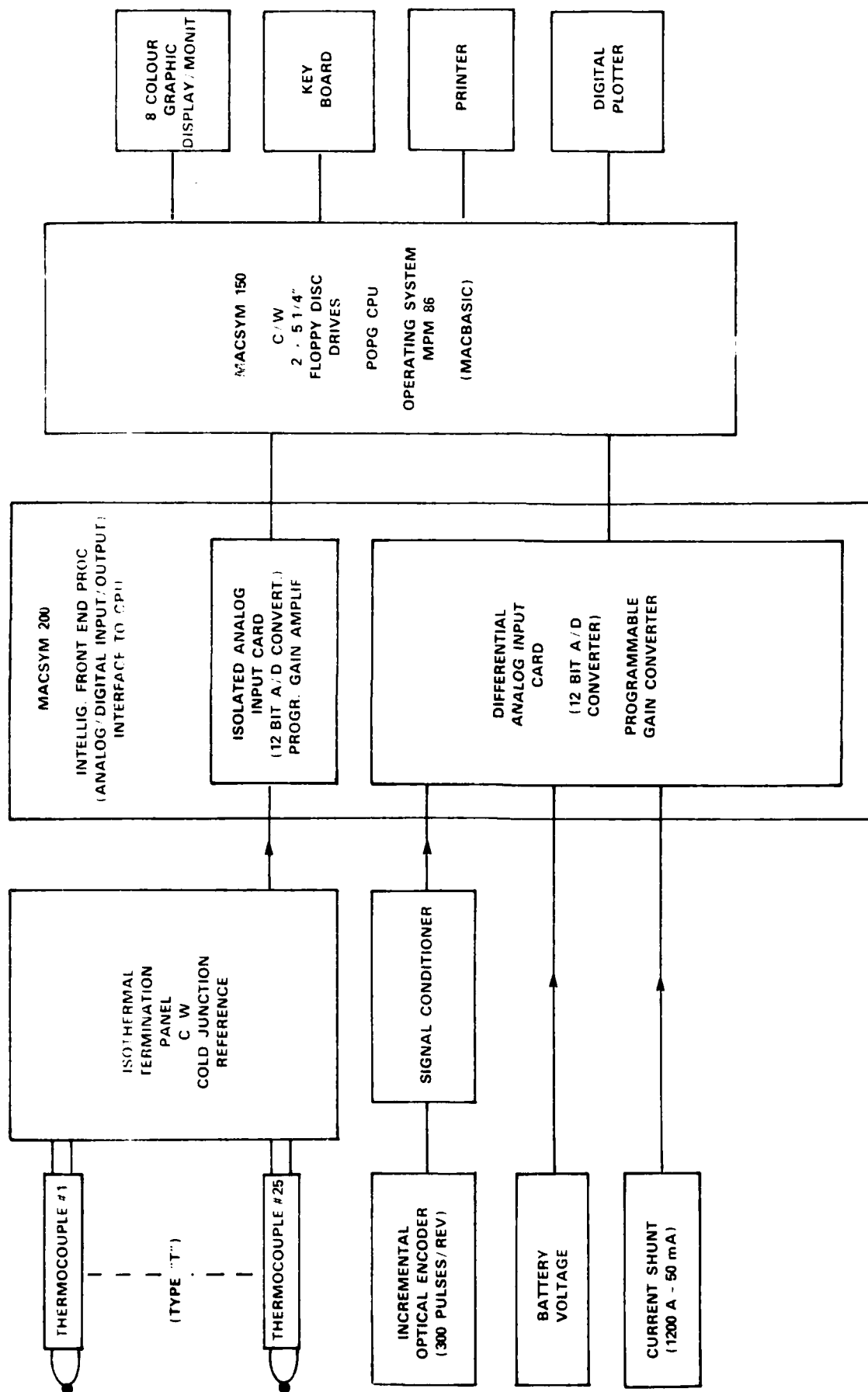


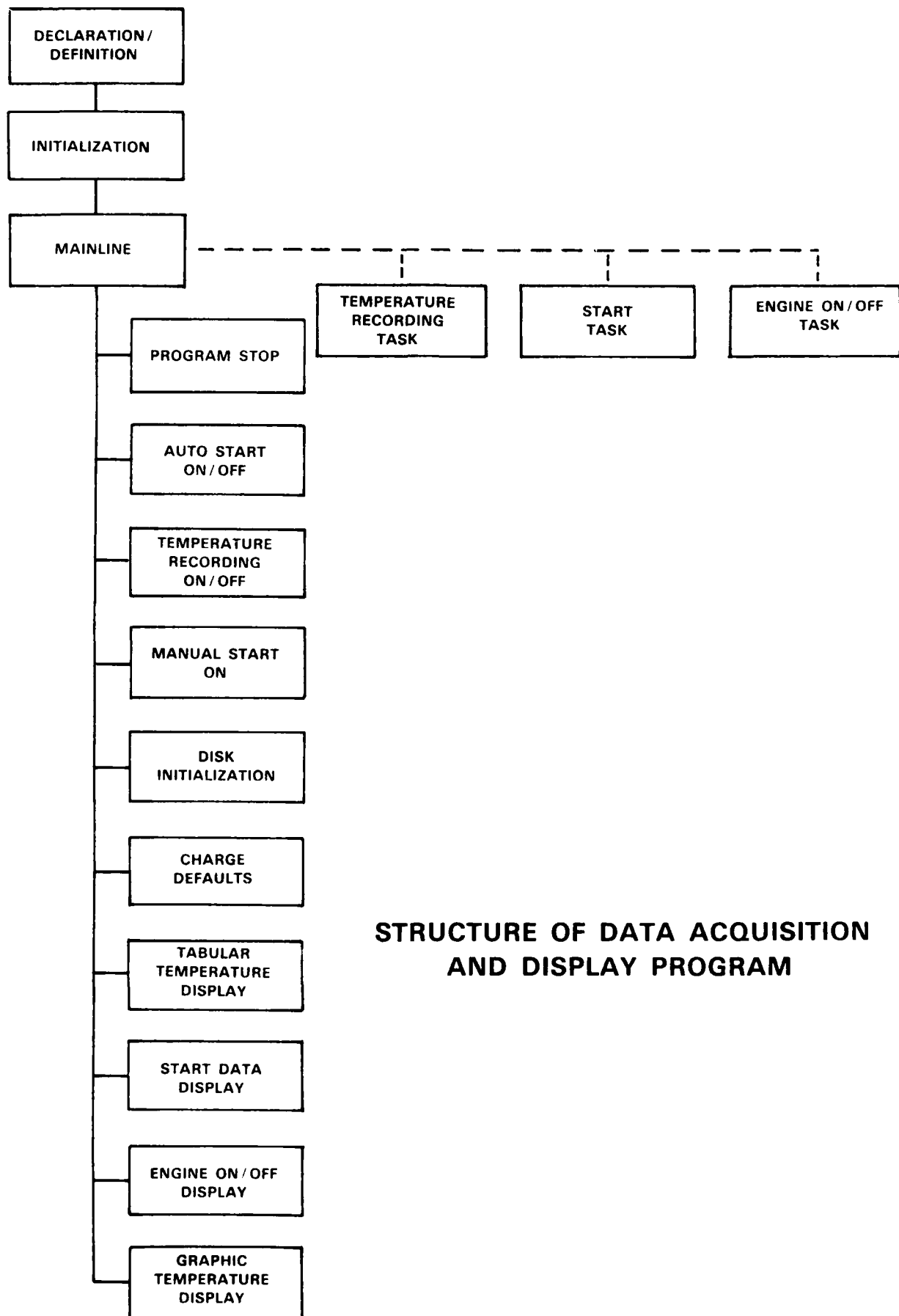
Figure B-6

DATA ACQUISITION SYSTEM HARDWARE

UNCLASSIFIED

/B-8

UNCLASSIFIED



**STRUCTURE OF DATA ACQUISITION
AND DISPLAY PROGRAM**

/B-10

UNCLASSIFIED

/B-11

F.

UNCLASSIFIED

UNCLASSIFIED

/B-12

```

1590 MINUS_COEFF(1) = 0
1600 MINUS_COEFF(2) = -2.38371E-2
1610 MINUS_COEFF(3) = -2.99788E-6
1620 MINUS_COEFF(4) = -7.19458E-10
1630 MINUS_COEFF(5) = -1.00419E-13
1640 PLUS_COEFF(1) = 0
1650 PLUS_COEFF(2) = 2.56613E-2
1660 PLUS_COEFF(3) = -6.19547E-7
1670 PLUS_COEFF(4) = 2.21916E-11
1680 PLUS_COEFF(5) = -3.55009E-16
1690
1700 DIM VEHICLE'(4,2,24) @ 24 THERMOCOUPLES MAX PER VE
HICLE
1710 FOR I' = 1 TO 15 @ FIRST INDEX IS VEHICLE NUMB
ER
1720 VEHICLE'(1,1,I') = 10 @ SECOND: 1 - SLOT, 2 - CHAN
NEL
1730 VEHICLE'(1,2,I') = I' - 1
1740 NEXT I'
1750 FOR I' = 16 TO 24
1760 VEHICLE'(1,1,I') = 10
1770 VEHICLE'(1,2,I') = I'
1780 NEXT I'
1790 FOR I' = 1 TO 6
1800 VEHICLE'(2,1,I') = 10
1810 VEHICLE'(2,2,I') = I' + 24
1820 NEXT I'
1830 FOR I' = 7 TO 20
1840 VEHICLE'(2,1,I') = 12
1850 VEHICLE'(2,2,I') = I' - 7
1860 NEXT I'
1870 VEHICLE'(3,1,1)=12
1880 VEHICLE'(3,2,1)=14
1890 FOR I=2 TO 16
1900 VEHICLE'(3,1,I)=12
1910 VEHICLE'(3,2,I)=I+14
1920 NEXT I
1930 VEHICLE'(3,1,17)=14
1940 VEHICLE'(3,2,17)=0
1950 FOR I' = 1 TO 8
1960 VEHICLE'(4,1,I') = 14
1970 VEHICLE'(4,2,I') = I'
1980 NEXT I'
1990
2000 DIM TEMP_FILE$(7) @ FIRST CHARACTER IS DISK, LA
ST
2010 TEMP_FILE$ = ' :TEMP ' @ IS VEHICLE NUMBER
2020
2030 DIM COUPLES'(5) @ NUMBER OF THERMOCOUPLES PER
VEHICLE
2040 COUPLES'(1) = 24
2050 COUPLES'(2) = 20
2060 COUPLES'(3) = 17
2070 COUPLES'(4) = 8
2080 COUPLES'(5) = 69
2090
2100 DIM NEW_TEMP(4,24)
2110 DIM OLD_TEMP(4,24)
2120 DIM OUT_TEMP(2,5) @ LAST TWO LOCATIONS FOR DATE
AND TIME
2130 DIM CJ_REF(5)

```

UNCLASSIFIED

UNCLASSIFIED

/B-13

```

2140
2150 DIM LINE23B$(5)
2160 LINE23B$(1) = CHR$(27) @ ESCAPE
2170 LINE23B$(2) = CHR$(61) @ EQUAL SIGN
2180 LINE23B$(3) = CHR$(54) @ ROW 23 + 31
2190 LINE23B$(4) = CHR$(32) @ COLUMN 1 + 31
2200 LINE23B$(5) = CHR$(7) @ BELL
2210
2220 @@@ START VARIABLES
2230
2240 DIM START$(10000)
2250 DIM START_SPEC$(3000)
2260 FOR I = 1 TO 3000 STEP 3
2270   START_SPEC$(I) = 3
2280 NEXT I
2290
2300 DIM START_FILE$(9)
2310 START_FILE$ = ' :START ' @ FIRST CHAR IS DISK, LAST IS
    VEHICLE
2320
2330 DIM LINE24B$(5)
2340 LINE24B$(1) = CHR$(27) @ ESCAPE
2350 LINE24B$(2) = CHR$(61) @ EQUAL SIGN
2360 LINE24B$(3) = CHR$(55) @ ROW 24 + 31
2370 LINE24B$(4) = CHR$(32) @ COLUMN 1 + 31
2380 LINE24B$(5) = CHR$(7) @ BELL
2390
2400 @@@ ENGINE VARIABLES
2410
2420 DIM ENGINE(3) @ 1 - ON/ 0 - OFF, DATE, TIME
2430
2440 DIM ENGINE_FILE$(8)
2450 ENGINE_FILE$ = ' :ENGINE ' @ FIRST CHAR IS DISK DRIVE
2460
2470 DIM LINE22B$(5)
2480 LINE22B$(1) = CHR$(27) @ ESCAPE
2490 LINE22B$(2) = CHR$(61) @ EQUAL SIGN
2500 LINE22B$(3) = CHR$(53) @ ROW 22 + 31
2510 LINE22B$(4) = CHR$(32) @ COLUMN 1 + 31
2520 LINE22B$(5) = CHR$(7) @ BELL
2530
2540 @@@ DISPLAY VARIABLES
2550
2560 DIM LINE20B$(5)
2570 DIM LINE20C$(5)
2580 LINE20B$(1) = CHR$(27) @ ESCAPE
2590 LINE20B$(2) = CHR$(61) @ EQUAL SIGN
2600 LINE20B$(3) = CHR$(51) @ ROW 20 + 31
2610 LINE20B$(4) = CHR$(32) @ COLUMN 1 + 31
2620 LINE20B$(5) = CHR$(7) @ BELL
2630 LINE20C$ = LINE20B$
2640 LINE20C$(5) = CHR$(162) @ LINE ERASE
2650
2660 DIM DIS_TEMP(26)
2680 DIM DIS_DEVICE$(1)
2690 DIM DIS_DISK$(1)
2700 DIM DIS_FILE$(9)
2710 DIM DIS_DATE1$(12)
2720 DIM DIS_DATE2$(12)
2730 DIM DIS_DATE3$(12)
2740 DIM CONTINUE$(1)

```

UNCLASSIFIED

/B-14

UNCLASSIFIED

UNCLASSIFIED

/B-15

UNCLASSIFIED

/B-16

UNCLASSIFIED

/B-17

UNCLASSIFIED

/B-18

UNCLASSIFIED

UNCLASSIFIED

/B-19

UNCLASSIFIED

UNCLASSIFIED

/B-20

```

6530      IF ABS(OLD_TEMP(I',J') - NEW_TEMP(I',J')) > COMPRESS_LTE
MP THEN COMPRESS = 1
6540      NEXT J'
6550      NEXT I'
6560
6570
6580      IF COMPRESS = 0 GOTO 7220
6590
6600      @@@ CHECK DISK SPACE, IF FULL CHECK OTHER DISK
6610
6620      IF BYTE_COUNT + COUPLES'(5) * 4 * 8 > DISK_SIZE GOTO 6800
6630      PRINT LINE23B$;
6640      PRINT " ** TEMP:  DISK #: DISK$;  * FULL: "; TAB(61); PTIME H
AIT 1
6650      IF DISK$ <> 'A' GOTO 6680
6660      DISKA' = 0
6670      GOTO 6690
6680      DISKB' = 0
6690      DISK$ = ' '
6700      IF DISKA' <> 1 GOTO 6730
6710      DISK$ = 'A'
6720      GOTO 6800
6730      IF DISKB' <> 1 GOTO 6760
6740      DISK$ = 'B'
6750      GOTO 6800
6760      PRINT LINE23B$;
6770      PRINT " ** TEMP:  NEW DISK REQUIRED IMMEDIATELY!! "; T
AB(61); PTIME
6780      WAIT 5
6790      GOTO 6700
6800      PRINT LINE23B$;
6810      PRINT " ** TEMP:  DISK DRIVE #: DISK$;  * NOW BEING USED ";
TAB(61); PTIME
6820      BYTE_COUNT = 0
6830      ON ERROR 212, 6870
6840      DSKRESET
6850      OFF ERROR
6860      GOTO 6890
6870      WAIT .5
6880      GOTO 6840
6890
6900      FOR I' = 1 TO 4
6910          TEMP_FILE$(1) = DISK$
6920          TEMP_FILE$(7) = STR$(I')
6930          ON ERROR 12, 6970
6940          OPENA: 2  TEMP_FILE$
6950          OFF ERROR
6960          GOTO 7000
6970          WAIT .5
6980          GOTO 6940
6990
7000          OUT_TEMP(COUPLES'(I')+1)=TEMP_YEAR'*10000+TEMP_MONTH'*10
+TEMP_DAY'
7010          OUT_TEMP(COUPLES'(I')+2)=TEMP_HOUR'*10000+TEMP_MIN'*100+
TEMP_SEC'
7020      FOR J' = 1 TO COUPLES'(I')
7030          OLD_TEMP(I', J') = NEW_TEMP(I', J')
7040          OUT_TEMP(J') = NEW_TEMP(I', J')
7050      NEXT J'
7060      ON ERROR 46, 7090
7070          SAVE ARRAY: 2  OUT_TEMP(1), COUPLES'(I') + 2

```

UNCLASSIFIED

UNCLASSIFIED

/B-21

```

7080      GOTO 7150
7090      PRINT LINE238$;
7100      PRINT ' ** TEMP: OUT OF DISK SPACE ON DRIVE ' ; DISK$
; '!!'; TAB(61); PTIME
7110      CLOSE: 2
7120      WAIT 1
7130      OFF ERROR
7140      GOTO 6650
7150      CLOSE: 2
7160      OFF ERROR
7170      NEXT I'
7180
7190      BYTE_COUNT = BYTE_COUNT + COUPLES'(5) * 4 + 8
7200
7210      *** DISK SPACE WARNING CHECK
7220      IF BYTE_COUNT > DISK_SIZE - COUPLES'(5) * 4 + 8 GOTO 7260
7230      PRINT LINE238$;
7240      PRINT ' ** TEMP: NEW DISK REQUIRED IN DRIVE ' ; DISK$; TAB(
61); PTIME
7250
7260      *** CHECK AUTOSTART
7270      IF ENGINE_ON' = 0 GOTO 7300
7280      IF NEW_TEMP(2,3) < OFF_TEMP GOTO 7332
7282      ACTIVATE 4
7283      GOTO 7340
7290      GOTO 7340
7300      IF NEW_TEMP(2,3) > ON_TEMP GOTO 7331
7302      ACTIVATE 4
7310      IF START_VEH' <> AUTO_VEH' GOTO 7340
7320      ACTIVATE 3
7321      GOTO 7340
7330
7331      AUTO_FLAG' = 0
7332      ENGINE_FLAG' = 0
7340      DISMISS
7350      GOTO 6040
7360      END
7370
7380      ****
7390      ***
8000      *** VEHICLE STARTING DATA RECORDING TASK
8010      ***
8020      ****
8030
8040      *** INITIALIZE VARIABLES
8050
8060      VEH' = START_VEH' @ START_VEH' COULD BE
T-RESET
8061      AUTO_FLAG' = 1
8070      IF VEH' = AUTO_VEH' GOTO 8190
8072      IF VEH'=1 GOTO 8110
8074      IF VEH'=3 GOTO 8140
8090      FOR K' = 2 TO 3000 STEP 12
8091      START_SPEC'(K')=10
8092      START_SPEC'(K'+1) = 5
8093      START_SPEC'(K'+3)=11
8094      START_SPEC'(K'+4) = 0
8095      START_SPEC'(K'+6) = 10
8096      START_SPEC'(K'+7) = 5

```

UNCLASSIFIED

UNCLASSIFIED

/B-22

```
8097 START_SPEC'(K'+9) = 12
8098 -START_SPEC'(K'+10) = 0
8099 NEXT K'
8100 GOTO 8300
8110 FOR K' = 2 TO 3000 STEP 12
8111 START_SPEC'(K') = 4
8112 START_SPEC'(K'+1) = 5
8113 START_SPEC'(K'+3) = 5
8114 START_SPEC'(K'+4) = 0
8115 START_SPEC'(K'+6) = 4
8116 START_SPEC'(K'+7) = 5
8117 START_SPEC'(K'+9) = 6
8118 START_SPEC'(K'+10) = 0
8119 NEXT K'
8120 GOTO 8300
8140 FOR K' = 2 TO 3000 STEP 12
8141 START_SPEC'(K') = 7
8142 START_SPEC'(K'+1) = 5
8143 START_SPEC'(K'+3) = 8
8144 START_SPEC'(K'+4) = 0
8145 START_SPEC'(K'+6) = 7
8146 START_SPEC'(K'+7) = 5
8147 START_SPEC'(K'+9) = 9
8148 START_SPEC'(K'+10) = 0
8149 NEXT K'
8180 GOTO 8300
8190 FOR K' = 2 TO 3000 STEP 12
8200 START_SPEC'(K') = 0
8210 START_SPEC'(K'+1) = 5
8220 START_SPEC'(K'+3) = 1
8230 START_SPEC'(K'+4) = 0
8240 START_SPEC'(K'+6) = 0
8250 START_SPEC'(K'+7) = 5
8260 START_SPEC'(K'+9) = 2
8270 START_SPEC'(K'+10) = 0
8280 NEXT K'
8290
8300 GDATE START_MONTH', START_DAY', START_YEAR'
8310 GTIME START_HOUR', START_MIN', START_SEC'
8326
8340
8380
8390 @@@ READ DATA
8400
8420 FOR K' = 1 TO 10000 STEP 1000
8430 SCAN (START_SPEC'(1), 1000, .00155) INTO START(K')
8440 NEXT K'
8445 FOR I=1 TO 9997 STEP 4
8446 LET START(I)=START(I)*24000
8447 LET START(I+1)=START(I+1)*3.0
8448 LET START(I+2)=START(I+2)*24000
8449 LET START(I+3)=START(I+3)*187.5
8450 NEXT I
8460
8470 START(10001) = START_YEAR'*10000 + START_MONTH'*100 + START_DA
Y'
8480 START(10002) = START_HOUR'*10000 + START_MIN'*100 + START_SEC'
8490
8500 @@@ DISK CHECK
8510
8520 IF BYTE_COUNT + 40008 < DISK_SIZE GOTO 8820
```

UNCLASSIFIED

UNCLASSIFIED

/B-23

```

8530 PRINT LINE24B$;
8540 PRINT ' ** START: DISK'; DISK$; ' FULL'; TAB(61); PTIME
WAIT 1
8550 IF DISK$ <> 'A' GOTO 8580
8560 DISK$ = 'A'
8570 GOTO 8590
8580 DISK$ = 'B'
8590 DISK$ = 'C'
8600 IF DISK$ <> 'C' GOTO 8630
8610 DISK$ = 'A'
8620 GOTO 8700
8630 IF DISK$ <> 'C' GOTO 8660
8640 DISK$ = 'B'
8650 GOTO 8700
8660 PRINT LINE24B$;
8670 PRINT ' ** START: NEW DISK REQUIRED IMMEDIATELY!!!';
TAB(61); PTIME
8680 WAIT 30
8690 GOTO 8600
8700 PRINT LINE24B$;
8710 PRINT ' ** START: DISK DRIVE'; DISK$; ' NOW BEING USED';
TAB(61); PTIME
8720 BYTE_COUNT = 0
8730 ON ERROR 212, 8770
8740 DSKRESET
8750 OFF ERROR
8760 GOTO 8820
8770 WAIT .5
8780 GOTO 8740
8790 TEMP_FILE$(1) = DISK$
8800
8810 @@@ WRITE DATA
8820 START_FILE$(1) = DISK$
8830 START_FILE$(8) = STR$(VEH')
8840 ON ERROR 12, 8880
8850 OPENA: 3 START_FILE$
8860 OFF ERROR
8870 GOTO 8910
8880 WAIT .5
8890 GOTO 8850
8900
8910 ON ERROR 46, 8940
8920 SAVE ARRAY: 3 START(1), 10002
8930 GOTO 8980
8940 PRINT LINE24B$;
8950 PRINT ' ** START: OUT OF DISK SPACE ON DRIVE'; DISK$; '!!'
'; TAB(61); PTIME
8960 WAIT 1
8970 GOTO 8550
8980 CLOSE: 3
8990
9000 @@@ DISK SPACE WARNING CHECK
9010
9020 BYTE_COUNT = BYTE_COUNT + 40008
9030 IF BYTE_COUNT < DISK_SIZE - 40008 GOTO 9070
9040 PRINT LINE24B$;
9050 PRINT ' ** START: NEW DISK REQUIRED IN DRIVE'; DISK$; TAB
(61); PTIME
9060
9070 IF START_VEH' <> AUTO_VEH' THEN START_VEH' = 0
9080 SUSPEND SELF

```

UNCLASSIFIED

UNCLASSIFIED

/B-24

```

9090 GOTO 8060
9100 END
9110
9120 #####
#####
9130 ###
10000 ### ENGINE ON/OFF TASK
10010 ###
10020 #####
#####
10031 ENGINE_FLAG' = 1
10040 ### TOGGLE ENGINE_ON
10050 IF ENGINE_ON' = 1 GOTO 10080
10060 ENGINE_ON' = 1
10070 GOTO 10100
10080 ENGINE_ON' = 0
10090
10100 IF ENGINE_ON' = 0 GOTO 10200
10110
10120 ### CHECK ENGINE
10130 IF AIN(6, 15, 0) < 3 GOTO 10260
10140 GDATE ENGINE_MONTH', ENGINE_DAY', ENGINE_YEAR'
10150 GTIME ENGINE_HOUR', ENGINE_MIN', ENGINE_SEC'
10160 ENGINE(2) = ENGINE_YEAR'*10000 + ENGINE_MONTH'*100 + EN
GINE_DAY'
10170 ENGINE(3) = ENGINE_HOUR'*10000 + ENGINE_MIN'*100 + ENGI
NE_SEC'
10180 ENGINE(1) = 1
10190 GOTO 10320
10200 IF AIN(6, 15, 0) > 1 GOTO 10260
10210 GDATE ENGINE_MONTH', ENGINE_DAY', ENGINE_YEAR'
10220 GTIME ENGINE_HOUR', ENGINE_MIN', ENGINE_SEC'
10230 ENGINE(2) = ENGINE_YEAR'*10000 + ENGINE_MONTH'*100 + EN
GINE_DAY'
10240 ENGINE(3) = ENGINE_HOUR'*10000 + ENGINE_MIN'*100 + ENGI
NE_SEC'
10245 ENGINE(1)=0
10250 GOTO 10320
10260 WAIT 1
10270 GOTO 10100
10280
10290
10300 ### DISK CHECK
10310
10320 IF BYTE_COUNT + 12 < DISK_SIZE GOTO 10400
10330 PRINT LINE22B$;
10340 PRINT ' ** ENGINE: DISK : DISK$: ' FULL!'; TAB(61); ETIM
E WAIT 1
10350 IF DISK$ <> 'A' GOTO 10380
10360 DISKA' = 0
10370 GOTO 10390
10380 DISKB' = 0
10390 DISK$ = ' '
10400 IF DISKA' <> 1 GOTO 10430
10410 DISK$ = 'A'
10420 GOTO 10500
10430 IF DISKB' <> 1 GOTO 10460
10440 DISK$ = 'B'
10450 GOTO 10500
10460 PRINT LINE22B$;
10470 PRINT ' ** ENGINE: NEW DISK REQUIRED IMMEDIATELY!!'

```

UNCLASSIFIED

UNCLASSIFIED

/B-25

```

; TAB(61); PTIME
10480      WAIT 2
10490      GOTO 10400
10500      PRINT LINE22R5;
10510      PRINT ' ** ENGINE: NEW DISK REQUIRED IMMEDIATELY !!'; TAB(
61); PTIME
10520      BYTE_COUNT = 0
10530      ON ERROR 212; 10570
10540      DISKRESET
10550      OFF ERROR
10560      GOTO 10600
10570      WAIT .5
10580      GOTO 10540
10590
10600      ENGINE_FILE$ = '1' + DISK$
10610      ON ERROR 12; 10650
10620      OPENA:4 ENGINE_FILE$
10630      OFF ERROR
10640      GOTO 10680
10650      WAIT .5
10660      GOTO 10620
10670
10680      ON ERROR 46; 10710
10690      SAVE ARRAY:4 ENGINE(1); 3
10700      GOTO 10760
10710      PRINT LINE22R2;
10720      CLOSE: 4
10730      PRINT ' ** ENGINE: OUT OF DISK SPACE ON DRIVE ' + DISK$
; '11'; TAB(61); PTIME
10740      WAIT 1
10750      GOTO 10350
10760      CLOSE: 4
10770      OFF ERROR
10780
10790      *** DISK SPACE WARNING CHECK
10800
10810      BYTE_COUNT = BYTE_COUNT + 12
10820      IF BYTE_COUNT > DISK_SIZE - 12 GOTO 10870
10830      PRINT LINE22R5;
10840      PRINT ' ** ENGINE: NEW DISK REQUIRED IN DRIVE ' + DI
SK$; TAB(61); PTIME
10850
10860
10870      SUSPEND-SELF
10880      GOTO 10050
10890      END
10900

11000      @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
@@@@@@@@@@@@@@@@
11010      @@@
11020      @@@  TABULAR TEMPERATURE DISPLAY SUBROUTINE
11030      @@@
11040      @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
@@@@@@@@@@@@@@@@
11050
11060      @@@ INITIALIZE VARIABLES
11070
11080      CHAN' = 1
11090      DIS_FILES = TEMP_FILES
11100
11110      @@@ INPUT CONTROL VARIABLES

```

UNCLASSIFIED

UNCLASSIFIED

/B-26

```

11120
11130 ON ERROR 122, 11320
11140 PRINT LINE20C$;
11150 INPUT * ** TEMPT: ENTER OUTPUT DEVICE SCREEN OR PRINTER (S/P
): * DIS_DEVICE$;
11160 PRINT LINE20C$;
11170 INPUT * ** TEMPT: ENTER DISK DRIVE (A/B): * DIS_DISK$
11180 PRINT LINE20C$;
11190 ON ERROR 205, 11320
11200 INPUT * ** TEMPT: ENTER VEHICLE NUMBER (0 - FOR ALL): * DIS_
VEH';
11210 PRINT LINE20C$;
11220 ON ERROR 122, 11320
11230 INPUT * ** TEMPT: ENTER STARTING DATE (YYMMDD): * DIS_DATE1$
(1,6)
11240 PRINT LINE20C$;
11250 INPUT * ** TEMPT: ENTER STARTING TIME (HHMMSS): * DIS_DATE1$
(7,12)
11260 PRINT LINE20C$;
11270 INPUT * ** TEMPT: ENTER END DATE (YYMMDD): * DIS_DATE2$(1,6)
11280 PRINT LINE20C$;
11290 INPUT * ** TEMPT: ENTER END TIME (HHMMSS): * DIS_DATE2$(7,12
)
11300 GOTO 11380
11310
11320 PRINT LINE20B$;
11330 PRINT * ** TEMPT: ILLEGAL INPUT REENTER VALUES!"; TAB(61); P
TIME
11340 GOTO 11130
11350
11360 @@@ DISABLE DISK
11370
11380 OFF ERROR
11390 IF DIS_DISK$ = 'A' GOTO 11420
11400 DISKB' = 0
11410 GOTO 11440
11420 DISKA' = 0
11430
11440 DIS_FILE$(1) = DIS_DISK$
11450 IF DIS_DEVICE$ = 'P' THEN CHAN' = 9
11460
11470 @@@ SET LIMITS
11480
11490 IF DIS_VEH' <> 0 GOTO 11530
11500 FIRST_VEH' = 1
11510 LAST_VEH' = 4
11520 GOTO 11590
11530 FIRST_VEH' = DIS_VEH'
11540 LAST_VEH' = DIS_VEH'
11550
11560
11570 @@@ PRINT HEADING
11580
11590 IF DIS_DEVICE$ <> 'P' FNT 174
11600 PRINT: CHAN' TAB(27); 'THERMOCOUPLE TEMPERATURES'
11610 PRINT: CHAN' * DATE TIME VEH';
11620 FOR L' = 1 TO 24
11630 IF L' <> 17 GOTO 11650
11640 IF DIS_DEVICE$ <> 'P' PRINT *
11650 PRINT USING: CHAN' * -##' L';
11660 NEXT L'

```

UNCLASSIFIED

UNCLASSIFIED

/B-27

```

11670 PRINT: CHAN'
11680 LINE_COUNT' = 3
11690
11700 *** OPEN FILES
11710
11720 ON ERROR 12: 11770
11730   FOR L' = FIRST_VEH' TO LAST_VEH'
11740     DIS_FILE$(7) = STR$(L')
11750     OPEN# 4 + L' DIS_FILE$
11760     GOTO 11770
11770     WAIT .1
11780     GOTO 11750
11790   NEXT L'
11800 OFF ERROR
11810
11820 *** READ FILE AND PRINT TEMPERATURES
11830
11840 ON ERROR 113: 12020
11850 FOR L' = FIRST_VEH' TO LAST_VEH'
11860   LOAD_ARRAY: 4 + L' DIS_TEMP(1), COUPLES'(L') + 1
11870   DIS_DATE3$(1,6) = STR$(DIS_TEMP(COUPLES'(L') + 1))
11880   DIS_DATE3$(7,12) = "000000"
11890   M' = LEN(STR$(DIS_TEMP(COUPLES'(L') + 2)))
11900   DIS_DATE3$(13-M',12) = STR$(DIS_TEMP(COUPLES'(L') + 2))
11910   IF DIS_DATE3$ < DIS_DATE1$ GOTO 12050
11920   IF DIS_DATE3$ > DIS_DATE2$ GOTO 12100
11930   PRINT: CHAN' DIS_DATE3$(1,6); " "; DIS_DATE3$(7,12)
; " "; L';
11940   FOR M' = 1 TO COUPLES'(L')
11950     IF M' <> 17 GOTO 11957
11956     IF DIS_DEVICE$ <> "P" PRINT: CHAN' "
;
11957   IF DIS_TEMP(M') < -99 GOTO 11977
11958   IF DIS_TEMP(M') > 99 GOTO 11977
11961   IF DIS_TEMP(M') > 0 GOTO 11970
11962   PRINT USING: CHAN' " -##" DIS_TEMP(M') -
;
11963   GOTO 11980
11970   PRINT USING: CHAN' " -##" DIS_TEMP(M') +
;
11972   GOTO 11980
11977   PRINT: CHAN' " ***";
11980   NEXT M'
11990   PRINT: CHAN'
12000   IF DIS_DEVICE$ = "P" GOTO 12050
12010   LINE_COUNT' = LINE_COUNT' + 2
12020   IF LINE_COUNT' < 24 GOTO 12050
12040   INPUT " ** TABLE: HIT RETURN FOR MORE: " CON
TINUE$
12050 NEXT L'
12060 GOTO 11850
12070
12080 PRINT LINE20B$;
12090 PRINT " ** TEMPT: END OF FILE ENCOUNTERED!"; TAB(61); FTIME
12100
12110 IF DIS_DISK$ = DISK$ GOTO 12180
12120 CONTINUE$ = " "
12130 WAIT .3
12140 PRINT LINE20C$;
12150 INPUT " ** TEMPT: ENTER 'C' TO CONTINUE WITH NEW DISK: " CO
NTINUE$

```

UNCLASSIFIED

/ B-28

UNCLASSIFIED

UNCLASSIFIED

UNCLASSIFIED

/B-29

```
13400 PRINT LINE20C$;
13410 INPUT * ** PLOTT: ENTER END DATE (YYMMDD): * DIS_DATE1$(1,6)
13420 PRINT LINE20C$;
13430 INPUT * ** PLOTT: ENTER END TIME (HHMMSS): * DIS_DATE2$(7,12)
)
13440 PRINT LINE20C$;
13450 ON ERROR 205, 13530
13460 INPUT * ** PLOTT: ENTER NUMBER OF THERMOCOUPLES TO PLOT (1-12)
X): * THERMOS'
13470 FOR L' = 1 TO THERMOS'
13480 PRINT LINE20C$;
13490 INPUT * ** PLOTT: ENTER THERMOCOUPLE NUMBER: * DIS_COUPL
E'(L')
13500 NEXT L'
13510 GOTO 13590
13520
13530 PRINT LINE20B$;
13540 PRINT * ** PLOTT: ILLEGAL INPUT REENTER VALUES! * TAB(1); P
TIME
13550 GOTO 13290
13560
13570 @@@ DISABLE DISK
13580
13590 OFF ERROR
13600 IF DIS_DISK$ = 'A' GOTO 13630
13610 DISKR$ = 0
13620 GOTO 13660
13630 DISKA' = 0
13640 DISLAY 0
13650
13660 DIS_FILE$ = TEMP_FILE$
13661 DIS_FILE$(1) = DIS_DISK$
13670
13680 @@@ PRINT VEHICLE DATA
13690
13700 WINDOW 0, 80, 0, 80
13710 COLOR 7
13720 HPRINT DIS_VEH' * 18 - 9, 73, STR$(DIS_VEH')
13730 HPRINT DIS_VEH' * 18 - 5, 73, DIS_DATE1$(1,6)
13740 HPRINT DIS_VEH' * 18 - 5, 70, DIS_DATE2$(1,6)
13750 HPRINT DIS_VEH' * 18 + 2, 73, DIS_DATE1$(7,12)
13760 HPRINT DIS_VEH' * 18 + 2, 70, DIS_DATE2$(7,12)
13770 FOR L' = 1 TO THERMOS'
13780 COLOR L'
13790 HPRINT DIS_VEH' * 18 - 12 + 3 * L', 67, STR$(DIS_COUPLE'(L
'))
13800 NEXT L'
13810 COLOR 7
13850
13859
13860 @@@ OPEN FILE
13870 CONTINUE$ = ' '
13871 CONTINUE$ = ' '
13880 ON ERROR 12, 13920
13890 DIS_FILE$(7) = STR$(DIS_VEH')
13900 OPENR$ = 5 DIS_FILE$
13901 EOF' = 0
13902 NPTS' = 0
13903 IF CONTINUE$ = 'C' THEN DIS' = THERMOS' * 2
13910 GOTO 13940
13920 WAIT .1
```

UNCLASSIFIED

UNCLASSIFIED

/B-30

```

13930 GOTO 13900
13940 GFF ERROR
13950
13960 @@@ READ FILE AND PLOT TEMPERATURES
13970 PLOT_TIME = VAL$(DIS_DATE1$(11,12)) + VAL$(DIS_DATE1$(9,10))
* 60 + VAL$(DIS_DATE1$(7,8)) * 3600
13980 PLOT_DATE = VAL$(DIS_DATE1$(5,6)) + VAL$(DIS_DATE1$(3,4)) * 3
0
13990 DIS_TMP = VAL$(DIS_DATE2$(11,12)) + VAL$(DIS_DATE2$(9,10)) *
60 + VAL$(DIS_DATE2$(7,8)) * 3600 - PLOT_TIME
14000 DIS_TMP = DIS_TMP + (VAL$(DIS_DATE2$(5,6)) + VAL$(DIS_DATE2$(
3,4)) * 30 - PLOT_DATE) * 86400
14010 WINDOW DIS_TMP / 100 * -10, DIS_TMP, -50, 150
14020 IF PLOTTER$ <> "P" DISPLAY 4-
14030
14040 ON ERROR 113, 14195
14050 LOAD ARRAY: 5-DIS_TEMP(1), COUPLES'(DIS_VEH') + 2
14060 DIS_DATE3$(1,6) = STR$(DIS_TEMP(COUPLES'(DIS_VEH') + 1))
14070 DIS_DATE3$(7,12) = "000000"
14080 M' = LEN(STR$(DIS_TEMP(COUPLES'(DIS_VEH') + 2)))
14090 DIS_DATE3$(13-M',12) = STR$(DIS_TEMP(COUPLES'(DIS_VEH') +
2))
14100 IF DIS_DATE3$ < DIS_DATE1$ GOTO 14050
14101 IF DIS_DATE3$ > DIS_DATE2$ GOTO 14201
14110 FOR L' = 1 TO THERMOS' * 2 STEP 2
14140 DIS_START(NPTS'+L') = VAL$(DIS_DATE3$(11,12)) + VAL$(DIS_DA
TE3$(9,10)) * 60 + VAL$(DIS_DATE3$(7,8)) * 3600 - PLOT_TIME
14150 DIS_START(NPTS'+L') = DIS_START(NPTS'+L') + (VAL$(DIS_DATE3
$(5,6)) + VAL$(DIS_DATE3$(3,4)) * 30 - PLOT_DATE) * 86400
14160 DIS_START(NPTS'+L'+1) = DIS_TEMP(DIS_COUPLE'((L'+1)/2))
14180 NEXT L'
14181 NPTS' = NPTS' + THERMOS' * 2
14190 IF NPTS' < 10000 - THERMOS' * 2 GOTO 14050
14191 GOTO 14201
14192
14195 EOF' = 1
14196
14200
14201 FOR L' = 1 TO THERMOS' * 2 STEP 2
14202 MOVE DIS_START(L'), DIS_START(L'+1)
14203 COLOR (L'+1) / 2
14204 FOR M' = L' + THERMOS' * 2 TO NPTS' STEP THERMOS' * 2
14205 PLOT DIS_START(M'), DIS_START(M' + 1)
14206 NEXT M'
14207 NEXT L'
14208
14209 FOR L' = 1 TO THERMOS' * 2
14210 DIS_START(L') = DIS_START(NPTS' - THERMOS' * 2 + L')
14212 NEXT L'
14213 IF DIS_DATE3$ > DIS_DATE2$ GOTO 14350
14214 IF EOF' <> 1 GOTO 14050
14215
14220 WAIT 2
14230 DISPLAY 0
14240 PRINT LINE20B$;
14250 PRINT " ** PLOTT: END OF FILE ENCOUNTERED!"; TAB(61); PTIME
14260
14270 IF DIS_DISK$ = DISK$ GOTO 14350
14280 CONTINUE$ = " "
14290 WAIT 3
14300 DISPLAY 0

```

UNCLASSIFIED

UNCLASSIFIED

/B-31

```

14301 CLOSE: 5
14310 PRINT LINE20C$;
14320 INPUT " ** PLOTT: ENTER 'C' TO CONTINUE WITH NEW DISK: "
CONTINUE$
14330 IF CONTINUE$ = "C" GOTO 14400
14331 GOTO 14355
14340
14350 CLOSE: 5
14355 PRINT LINE20C$;
14360 WAIT 2
14370 DISPLAY 0
14380 INPUT " ** PLOTT: ENTER 'V' TO CONTINUE WITH ANOTHER VEHI
CLE: " CONTINUE$
14390
14400 OFF ERROR
14410
14420
14430 IF CONTINUE$ = "C" GOTO 13880
14440 IF CONTINUE$ = "V" GOTO 13330
14450
14460 IF PLOTTER$ = "P" GOTO 14520
14461 DISPLAY 0 WAIT 2
14470 PRINT LINE20C$;
14480 PRINT " ** PLOTT: HIT RETURN TO CLEAR PLOT"; TAB(61); PTIME
14490 WAIT 2
14500 DISPLAY 4
14510 INPUT " " CONTINUE$
14520 DISPLAY 0
14530
14540 RETURN
14550 END
15000 #####
000000000000
15010 000
15020 000 START DATA DISPLAY SUBROUTINE
15030 000
15040 #####
000000000000
15050
15051 000 REQUEST PLOTTING DEVICE
15052
15053 PLOTTER$ = "S"
15054 PRINT LINE20C$;
15055 INPUT " ** PLOTT: SELECT SCREEN OR PLOTTER (S/P): " PLOTTER
$
15056 PRINT LINE20C$;
15057 INPUT " ** PLOTT: ENTER RPM GAIN: " SGAIN
15058
15060 000 INITIALIZE GRAPHICS
15070
15071 IF PLOTTER$ <> "P" GOTO 15080
15072 GRAPHICS 5,1,1
15073 GOTO 15095
15080 GRAPHICS 4
15090 CLS 4
15095 COLOR 7
15100 WINDOW 0, 80, 0, 80
15110 HPRINT 35, 77, "START DATA"
15120 HPRINT 32, 1, "TIME (SECONDS)"
15130 COLOR 1
15140 VPRINT 60, 36, "VOLTAGE (V)"

```

UNCLASSIFIED

UNCLASSIFIED

/B-32

```
15150 COLOR 2
15160 VPRINT 3, 8, 'CURRENT (A) '
15170 COLOR 3
15180 VPRINT 3, 37, 'ENGINE SPEED (RPM) '
15190 COLOR 7
15200 WINDOW -2.5, 21.5, -200, 1600
15210 HAXISP 0, 2
15220 VAXISP 0, 100
15230 FOR L' = 0 TO 1600 STEP 100
15240   HPRINT -1.25, L' - 20, STR$(L')
15250 NEXT L'
15260 FOR L' = 0 TO 20 STEP 2
15270   HPRINT L' - .25, -80, STR$(L')
15280 NEXT L'
15290 WINDOW -2.5, 21.5, -4, 32
15300 VAXISP 20, 5
15310 FOR L' = 0 TO 32 STEP 5
15320   HPRINT 20.4, L' - .5, STR$(L')
15330 NEXT L'
15340
15350 @@@ INPUT CONTROL VARIABLES
15360
15370 DIS_FILE$ = START_FILE:
15380
15390 ON ERROR 122, 15520
15400 PRINT LINE20C$:
15410 INPUT ' ** STARTP: ENTER DISK DRIVE (A/B): ' DIS_DISK$
15420 PRINT LINE20C$:
15430 ON ERROR 205, 15520
15440 INPUT ' ** STARTP: ENTER VEHICLE NUMBER (1-4): ' DIS_VEH'
15450 PRINT LINE20C$:
15460 ON ERROR 122, 13530
15470 INPUT ' ** STARTP: ENTER STARTING DATE (YYMMDD): ' DIS_DATE1
15480 PRINT LINE20C$:
15490 INPUT ' ** STARTP: ENTER STARTING TIME (HHMMSS): ' DIS_DATE1
15500 GOTO 15560
15510
15520 PRINT LINE20B$
15530 PRINT ' ** STARTP: ILLEGAL INPUT REENTER VALUES!'; TAB(61);
15540 GOTO 15400
15550
15560 @@@ DISABLE DISK
15570
15580 OFF ERROR
15590 IF DIS_DISK$ = 'A' GOTO 15620
15600   DISKB' = 0
15610 GOTO 15640
15620   DISKA' = 0
15630
15640 DIS_FILE$(1) = DIS_DISK$
15650
15660 @@@ PRINT VEHICLE DATA
15670
15680 WINDOW 0, 80, 0, 80
15690 COLOR 7
15700 HPRINT DIS_VEH' * 16 - 4, 74, STR$(DIS_VEH')
15760
15770 @@@ OPEN FILE
```

UNCLASSIFIED

UNCLASSIFIED

/B-33

```
15780
15790 ON ERROR 17: 15830
15800 DIS_FILE$(3) = STR$(DIS_VEH')
15810 OPENR: 5 DIS_FILE$
15820 GOTO 15870
15830 PRINT LINE20B$;
15840 PRINT " ** STARTP: START FILE NOT FOUND!"; TAB(61); PTIME
15850 GOTO 16200
15860
15870 @@@ READ FILE AND PLOT DATA
15880
15890 IF PLOTTER$ <> "P" DISPLAY 4
15900
15910 ON ERROR 113, 16130
15920 LOAD ARRAY: 5 DIS_START(1), 10002
15930 DIS_DATE3$(1,6) = STR$(DIS_START(10001))
15940 DIS_DATE3$(17,12) = "000000"
15950 M' = LEN(STR$(DIS_START(10002)))
15960 DIS_DATE3$(13-M',12) = STR$(DIS_START(10002))
15961 IF DIS_DATE3$ < DIS_DATE1$ GOTO 15920
15962 HPRINT DIS_VEH' * 16 - 4.5, 74, DIS_DATE3$(1,6)
15963 HPRINT DIS_VEH' * 16 + 2, 74, DIS_DATE3$(7,12)
15970 COLOR 1
15980 WINDOW -2.5, 21.5, -4, 32
15990 MOVE 0,0
16000 FOR L' = 2 TO 10000 STEP 4
16010 PLOT L' * .002, DIS_START(L')
16020 NEXT L'
16030 WINDOW -2.5, 21.5, -200, 1600
16042 COLOR 2
16043 MOVE 0,0
16044 FOR L' = 1 TO 10000 STEP 2
16045 PLOT L' * .002, DIS_START(L')
16046 NEXT L'
16080 COLOR 3
16082 MOVE 0,0
16084 FOR L' = 4 TO 10000 STEP 4
16086 PLOT L' * .002, DIS_START(L') * SGAIN
16088 NEXT L'
16110 GOTO 16180
16120
16130 WAIT 2
16140 DISPLAY 0
16150 PRINT LINE20B$;
16160 PRINT " ** STARTP: END OF FILE ENCOUNTERED!"; TAB(61); PTIME
16170
16180 CLOSE: 5
16190
16200 OFF ERROR
16210 WAIT 1
16220 DISPLAY 0
16230 PRINT LINE20C$;
16240 INPUT " ** STARTP: ENTER 'C' TO CONTINUE WITH ANOTHER START:
      " CONTINUE$
16250 IF CONTINUE$ = "C" GOTO 15400
16260
16270 IF PLOTTER$ = "P" GOTO 16320
16271 PRINT LINE20C$;
16280 PRINT " ** STARTP: HIT RETURN TO CLEAR PLOT!"; TAB(61); PTIME
16290 WAIT 2
16300 DISPLAY 4
```

UNCLASSIFIED

/B-34

UNCLASSIFIED

UNCLASSIFIED

ANNEX C
DATA FROM VEHICLE EQUIPPED WITH
A HOT AIR HEATING SYSTEM

UNCLASSIFIED

INDEX FOR ANNEX C

Page No.

Temperature Data from Vehicle Heated with

Hot Air and Heater Exhaust	C - 4
Legend for Annex C Temperature Data	C - 5

	<u>Date</u>	<u>Time</u>	<u>Date</u>	<u>Time</u>		
Table C - 1	840124	130000	840125	130000	.....	C - 6
Figure C - 1	840124	130000	840125	130000	.....	C - 7
Table C - 2	840125	110000	840126	110000	.....	C - 8
Figure C - 2	840125	110000	840126	110000	.....	C - 10
Table C - 3	840126	110000	840127	110000	.....	C - 11
Figure C - 3	840126	110000	840127	110000	.....	C - 12
Table C - 4	840127	103000	840128	103000	.....	C - 13
Figure C - 4	840127	103000	840128	103000	.....	C - 15
Table C - 5	840128	103000	840129	103000	.....	C - 16
Figure C - 5	840128	103000	840129	103000	.....	C - 18
Table C - 6	840129	103000	840130	103000	.....	C - 19
Figure C - 6	840129	103000	840130	103000	.....	C - 20
Table C - 7	840130	123000	840131	123000	.....	C - 21
Figure C - 7	840130	123000	840131	123000	.....	C - 23
Table C - 8	840131	080000	840201	080000	.....	C - 24
Figure C - 8	840131	080000	840201	080000	.....	C - 26
Table C - 9	840201	083000	840202	083000	.....	C - 27
Figure C - 9	840201	083000	840202	083000	.....	C - 30
Table C - 10	840202	092000	840203	092000	.....	C - 31
Figure C - 10	840202	092000	840203	092000	.....	C - 34

Starting Data from Vehicle Heated with

Hot Air and Heater Exhaust	C - 35
----------------------------------	--------

	<u>Date</u>	<u>Time</u>		
Figure C - 11	840124	131207	.....	C - 36
Figure C - 12	840125	152609	.....	C - 37
Figure C - 13	840125	160356	.....	C - 38

UNCLASSIFIED

/C-3

INDEX FOR ANNEX C (Cont'd)

Page No.

	<u>Date</u>	<u>Time</u>		
Figure C - 14	840125	162040	.....	C - 39
Figure C - 15	840125	162151	.....	C - 40
Figure C - 16	840126	110437	.....	C - 41
Figure C - 17	840126	110715	.....	C - 42
Figure C - 18	840126	110850	.....	C - 43
Figure C - 19	840127	114622	.....	C - 44
Figure C - 20	840127	114743	.....	C - 45
Figure C - 21	840127	114847	.....	C - 46
Figure C - 22	840127	114950	.....	C - 47
Figure C - 23	840127	115105	.....	C - 48
Figure C - 24	840127	121541	.....	C - 49
Figure C - 25	840127	121757	.....	C - 50
Figure C - 26	840127	122033	.....	C - 51
Figure C - 27	840127	123603	.....	C - 52
Figure C - 28	840129	104333	.....	C - 53
Figure C - 29	840130	111309	.....	C - 54
Figure C - 30	840130	130829	.....	C - 55
Figure C - 31	840130	130941	.....	C - 56
Figure C - 32	840130	132035	.....	C - 57
Figure C - 33	840130	132150	.....	C - 58
Figure C - 34	840130	133832	.....	C - 59

UNCLASSIFIED

**TEMPERATURE DATA
FROM VEHICLE HEATED WITH
HOT AIR AND HEATER EXHAUST**

NOTE:

1. An unplugged thermocouple breaks the thermocouple circuit and causes the data acquisition system to measure common mode voltage which, in most cases, corresponds to a very high temperature. In those situations the temperature is far beyond the range used for actual temperature measurements and therefore the temperature is displayed in the tables as '***' and will not appear on the temperature plots except as a line descending directly down from a very high temperature to a legitimate reading. These occur on several occasions in Annex C but must be disregarded as they have absolutely no bearing on the temperatures which occurred in the vehicles.
2. Although temperature data were recorded at one minute intervals during the test period, to reduce the amount contained in this Annex, data are presented only after each change of 4°C in any thermocouple reading.

AD-A195 288

IMPROVING LOW TEMPERATURE STARTABILITY OF M113
VEHICLES: HOT AIR HEATING TESTS(U) DEFENCE RESEARCH
ESTABLISHMENT SUFFIELD RALSTON (ALBERTA)

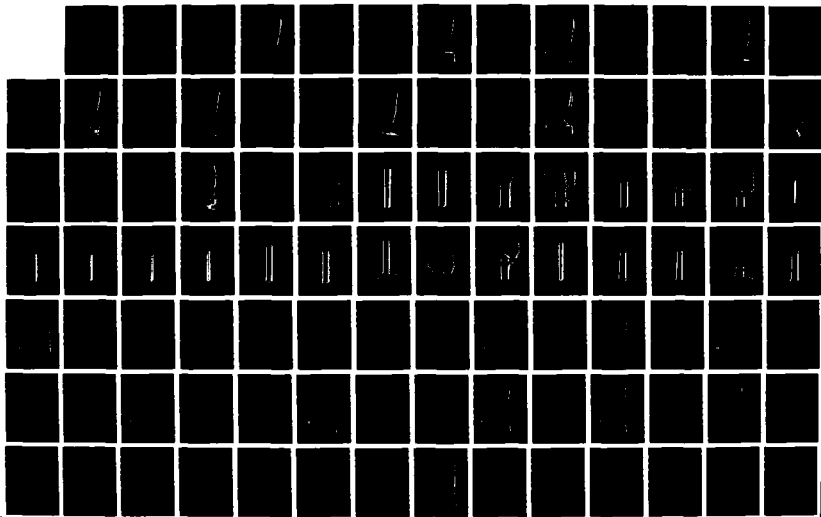
2/3

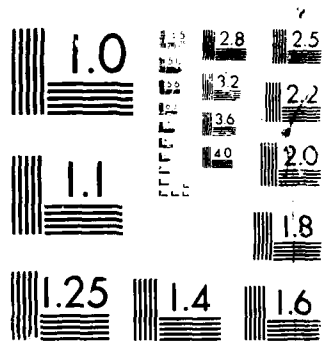
UNCLASSIFIED

T F STUPICH ET AL. MAR 88 DRES-SM-1165

F/G 19/3

NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

LEGEND FOR ANNEX C TEMPERATURE DATA

1. Oil — Oil Pan, Front
2. Oil — Oil Pan, Rear
3. Coolant — Thermostat Housing
4. Coolant — Connector Pipe, Oil Cooler to Engine Block
5. Coolant — Engine Block, Right
6. Coolant — Cylinder Head, Rear, Right
7. Air — Engine Bay, Front
8. Air — Engine Bay, Rear
9. Air — Air Inlet Horn
10. Fuel — Fuel Inlet
11. Electrolyte — Battery, Forward
12. Air — Battery Box
13. Air — Crew Compartment, Front
14. Air — Crew Compartment, Rear
15. Exhaust Gas — Mixing Pipe Output
16. Air — Turboheater Output
17. Exhaust Gas — Turboheater Exhaust
18. Air — Outside of Vehicle

UNCLASSIFIED

/C-6

Table C-1

THERMOCOUPLE TEMPERATURES

		THERMOCOUPLE TEMPERATURES																	
DATE	TIME VEH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
840124	130406 3	4	3	4	3	4	4	3	2	3	3	1	0	3	2	***	1	1	2
840124	131306 3	9	7	6	6	4	6	4	2	4	2	1	- 0	3	2	***	0	0	1
840124	131406 3	15	12	10	10	4	10	6	2	4	1	0	- 0	3	2	***	0	0	- 0
840124	131706 3	19	14	14	13	6	14	6	3	5	1	0	0	3	1	***	0	0	0
840124	131806 3	28	26	21	19	8	20	11	3	5	1	0	- 0	3	1	***	0	0	0
840124	131906 3	34	32	27	26	10	26	12	3	7	1	0	0	3	2	***	1	1	1
840124	132006 3	39	38	32	31	13	31	13	3	7	1	0	- 0	3	3	***	0	0	0
840124	132106 3	44	42	38	36	16	36	16	4	8	2	- 0	- 0	3	1	***	0	0	1
840124	132206 3	47	45	42	41	21	41	17	5	9	3	- 0	0	3	1	***	0	0	1
840124	132306 3	50	48	44	42	34	43	18	7	9	5	0	0	3	- 0	***	0	0	1
840124	132406 3	53	51	45	43	38	44	19	7	10	5	- 0	- 0	3	1	***	0	1	0
840124	132606 3	57	57	48	47	43	47	24	9	12	6	0	- 0	3	5	***	0	0	- 0
840124	132806 3	61	58	52	51	47	51	22	10	14	7	0	- 0	3	6	***	0	0	- 1
840124	133006 3	63	63	55	54	51	55	22	12	15	8	0	- 0	2	3	***	0	- 0	- 1
840124	133306 3	66	62	59	58	56	58	28	16	17	10	- 0	- 0	2	- 0	***	0	0	- 1
840124	133606 3	69	67	63	61	59	62	30	18	19	10	- 0	- 0	2	0	***	0	0	- 0
840124	134006 3	74	70	67	66	64	66	33	20	21	11	- 0	- 0	3	- 0	***	0	0	- 1
840124	134406 3	77	76	71	69	68	70	35	23	23	13	0	- 0	3	2	***	0	0	- 1
840124	134506 3	76	77	70	69	66	69	37	30	24	14	- 0	- 0	3	1	***	0	1	- 1
840124	134706 3	74	76	70	69	66	69	36	31	26	18	- 0	0	3	2	***	0	0	- 1
840124	134906 3	73	76	70	69	66	68	35	30	27	22	0	0	4	2	***	0	0	- 1
840124	135206 3	71	75	69	69	68	66	35	32	29	27	0	0	4	3	***	0	0	- 2
840124	135606 3	69	75	68	67	68	63	35	32	30	31	0	0	4	3	***	0	1	- 1
840124	140406 3	67	73	66	65	66	60	32	31	34	35	0	1	4	3	***	1	1	- 4
840124	153509 3	48	49	51	44	50	44	26	28	36	35	1	1	3	3	***	1	1	- 4
840124	163508 3	39	39	43	36	43	36	22	25	31	32	0	0	1	2	***	- 1	- 0	- 5
840124	171315 3	34	34	38	32	38	33	19	22	28	28	- 0	- 1	- 1	1	***	- 2	- 1	- 6
840124	175115 3	30	30	35	28	35	29	16	19	26	25	- 1	- 1	- 1	- 0	***	- 3	- 2	- 7
840124	182715 3	27	26	31	25	31	25	13	16	22	22	- 1	- 2	- 3	- 1	***	- 4	- 3	- 8
840124	190905 3	23	23	26	21	27	21	10	13	18	19	- 2	- 3	- 4	- 3	***	- 5	- 5	-10
840124	195745 3	19	19	22	18	23	17	7	10	15	15	- 3	- 4	- 6	- 4	***	- 6	- 6	-11
840124	204326 3	16	16	18	14	19	14	4	7	12	12	- 4	- 4	- 7	- 6	***	- 8	- 7	-12
840124	214832 3	12	12	13	10	14	10	1	4	7	8	- 5	- 6	-10	- 8	***	-10	- 9	-13
840124	225832 3	8	8	9	6	10	7	- 1	1	4	5	- 6	- 7	-11	-10	***	-11	-11	-14
840125	001432 3	5	5	5	3	6	3	- 4	- 1	1	2	- 7	- 8	-12	-11	***	-13	-13	-15
840125	014832 3	1	1	1	- 0	2	- 0	- 6	- 4	- 2	- 2	- 8	-10	-14	-13	***	-14	-14	-17
840125	040332 3	- 3	- 3	- 3	- 4	- 2	- 4	- 8	- 7	- 5	- 5	-10	-12	-16	-15	***	-16	-16	-18
840125	063832 3	- 7	- 6	- 7	- 7	- 6	- 8	-11	-10	- 9	- 8	-12	-13	-17	-16	***	-17	-17	-18
840125	090410 3	- 9	- 1	- 9	-10	- 8	-10	-13	-12	-10	-10	-14	-15	-18	-17	***	-18	-18	-18
840125	090437 3	- 9	- 9	- 9	-10	- 8	-10	- 1	-12	-10	-10	-14	-15	-18	-17	***	-18	-18	-18
840125	090511 3	- 9	- 9	- 9	-10	- 8	-10	-13	-12	-11	-11	-14	- 1	-18	-17	***	-18	-18	-18
840125	090534 3	- 9	- 9	- 9	-10	- 9	-10	-13	-12	-11	-10	-14	-15	-18	-17	***	-18	- 2	-18
840125	090602 3	- 9	- 9	- 9	-10	- 9	-10	-13	-12	-11	-11	-14	-15	-18	-17	***	-18	-18	-18
840125	092947 3	- 9	0	-10	-10	- 9	-11	-13	-12	-11	-11	-14	-15	-18	-17	***	-18	-18	-17
840125	093042 3	-10	- 9	-10	-10	- 9	-11	0	-12	-11	-11	-14	-15	-18	-17	***	-18	-18	-17
840125	093138 3	- 9	- 9	-10	-10	- 9	-11	-13	-12	-11	-11	-14	0	-18	-17	***	-18	-18	-17
840125	093230 3	-10	- 9	-10	-10	- 9	-11	-13	-12	-11	-11	-14	-15	-18	-17	***	-18	- 0	-18
840125	093334 3	- 9	- 9	-10	-10	- 9	-11	-13	-12	-11	-11	-14	-15	-18	-17	***	-18	-18	-17
840125	100856 3	-10	-10	-10	-10	- 9	-11	98	-12	-11	-11	-14	-15	-17	-17	***	-18	-18	-17
840125	100941 3	-10	-10	-10	-10	-10	-11	-13	-12	-11	-11	-14	***	-17	-17	***	-18	-18	-17
840125	101039 3	-10	-10	-10	-11	-10	-11	-13	-13	-11	-11	-14	-15	-18	-17	***	-18	***	-17
840125	101129 3	-10	-10	-10	-11	- 9	-11	-13	-13	-11	-11	-14	-15	-17	-17	***	-18	-19	-17
840125	121347 3	-11	-11	-11	-12	-11	-12	-13	-13	-12	-12	-13	-14	-12	-14	***	-15	-16	-14

UNCLASSIFIED

UNCLASSIFIED

/C-7

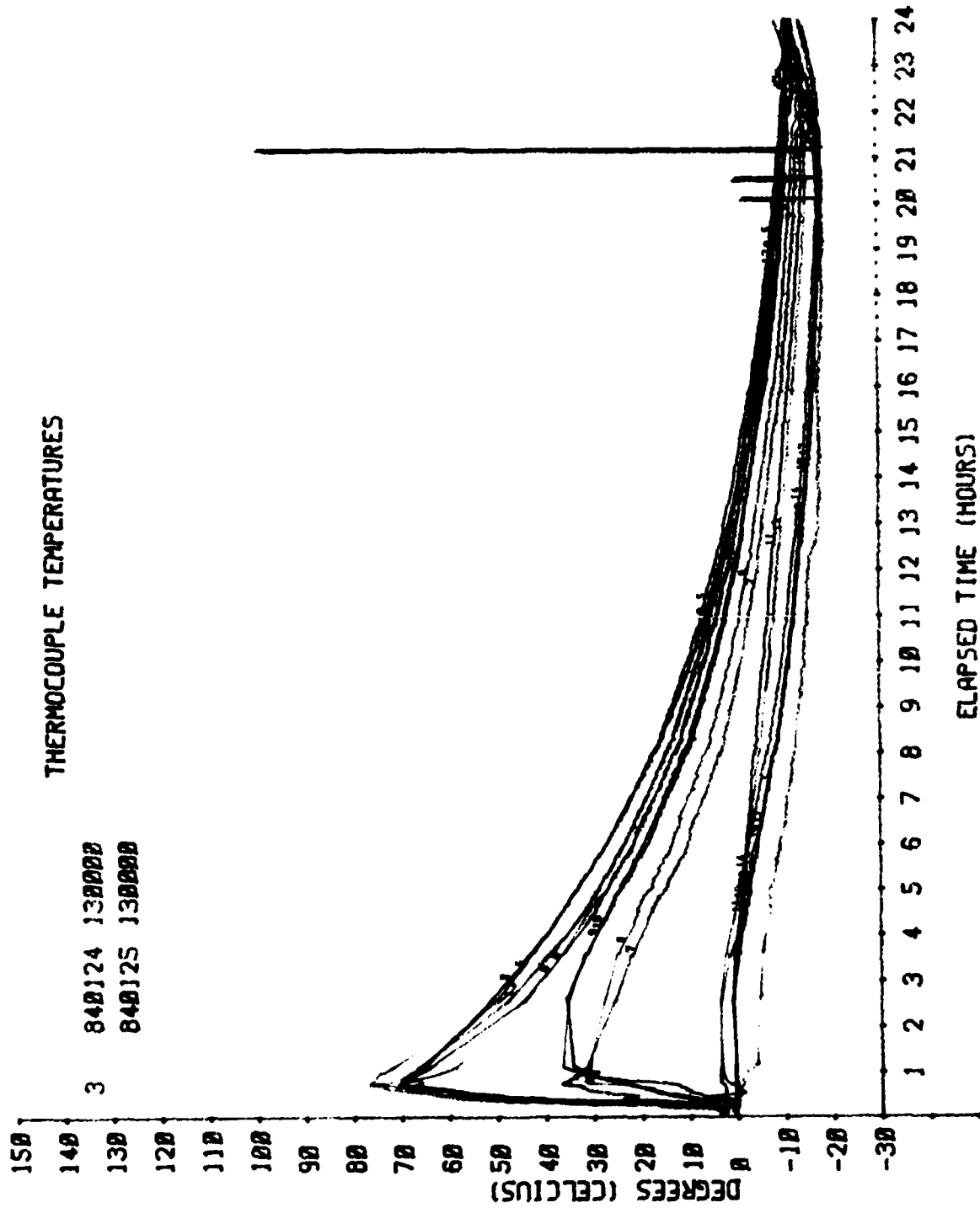


Figure C-1

UNCLASSIFIED

UNCLASSIFIED

/C-8

Table C-2

THERMOCOUPLE TEMPERATURES

THERMOCOUPLE TEMPERATURES																				
DATE	TIME	VEH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
840125	110036	3	-11	-10	-11	-11	-10	-12	-14	-13	-12	-12	-14	-15	-16	-16	***	-17	-18	-16
840125	121347	3	-11	-11	-11	-12	-11	-12	-13	-13	-12	-12	-13	-14	-12	-14	***	-15	-16	-14
840125	140158	3	-11	-11	-10	-11	-11	-11	-8	-9	-10	-10	-10	-11	-7	-9	***	-11	-11	-12
840125	153614	3	-11	-12	-10	-11	-11	-11	-10	-10	-10	-11	-11	-11	-12	-10	***	-11	-11	-15
840125	154943	3	-11	-12	-10	-11	-11	-11	-8	-9	-10	-10	-11	-11	-7	-10	***	-12	-12	-15
840125	155008	3	-11	-11	-10	-11	-10	-11	-3	-7	-10	-11	-11	-10	-6	-8	***	-12	-12	-15
840125	155048	3	-10	-11	-10	-11	-10	-11	3	-4	-10	-10	-10	-10	-7	-6	***	-12	-12	-14
840125	155231	3	-9	-11	-9	-11	-10	-10	9	1	-9	-9	-10	-7	-6	-2	***	-4	85	-14
840125	155240	3	-9	-10	-9	-11	-10	-10	9	1	-9	-9	-10	-7	-6	-2	***	-2	98	-15
840125	155325	3	-8	-9	-9	-11	-10	-10	11	3	-9	-8	-10	-1	-3	-1	***	8	***	-15
840125	155425	3	-6	-7	-8	-10	-10	-10	12	5	-8	-7	-9	6	1	0	***	23	***	-15
840125	155613	3	-4	-1	-8	-9	-9	-9	15	8	-6	-6	-6	21	10	3	***	49	***	-14
840125	155713	3	-2	3	-8	-9	-9	-9	16	10	-4	-5	-4	28	14	4	***	60	***	-15
840125	155839	3	-0	9	-7	-8	-8	-8	19	11	-1	-4	-1	36	20	6	***	70	***	-15
840125	155936	3	1	12	-6	-8	-8	-8	19	12	0	-3	1	40	22	6	***	75	***	-15
840125	160136	3	4	16	-5	-7	-8	-7	20	14	4	-2	5	45	27	6	***	79	***	-15
840125	160342	3	5	20	-4	-7	-7	-6	21	17	8	-0	9	47	30	2	***	81	***	-15
840125	160442	3	4	26	-3	-6	-7	-8	22	18	3	-2	11	49	31	5	***	83	***	-15
840125	160605	3	4	21	-2	-6	-7	-6	21	19	8	-0	12	51	33	7	***	87	***	-15
840125	160805	3	5	25	-2	-5	-6	-5	22	21	13	2	15	52	31	7	***	90	***	-14
840125	161031	3	8	30	-1	-4	-5	-2	23	20	17	4	16	53	30	7	***	95	***	-14
840125	161131	3	8	31	-1	-4	-5	-1	24	20	18	5	17	56	35	9	***	97	***	-15
840125	161431	3	12	36	1	-4	-4	1	27	23	21	7	20	59	39	12	***	***	***	-15
840125	161835	3	15	40	3	-4	-4	4	29	25	24	9	23	61	42	13	***	***	***	-15
840125	162041	3	15	45	4	-2	-3	-2	30	26	14	4	24	61	42	14	***	***	***	-15
840125	162141	3	15	39	4	-2	-3	1	29	26	17	8	25	62	42	12	***	***	***	-15
840125	162241	3	14	15	1	1	-3	1	26	22	16	3	24	62	42	10	***	***	***	-15
840125	162341	3	16	16	6	6	-2	6	15	15	15	-1	22	37	29	11	***	***	***	-15
840125	162441	3	18	15	8	8	-1	9	13	13	14	-0	22	23	22	10	***	***	***	-15
840125	162541	3	24	21	13	13	1	13	11	9	11	-4	16	18	19	7	***	***	***	-15
840125	162641	3	36	36	24	24	9	24	18	6	10	-5	16	16	17	6	***	***	***	-15
840125	162741	3	43	43	33	32	22	32	21	6	10	-5	15	14	15	8	***	***	***	-15
840125	162841	3	50	48	40	40	30	40	22	5	11	-4	14	13	14	8	***	***	***	-15
840125	162941	3	52	51	47	46	36	45	23	7	12	-3	13	10	8	3	***	***	***	-15
840125	163041	3	56	55	51	50	41	50	22	8	11	-2	12	9	7	3	***	***	***	-15
840125	163141	3	61	58	57	56	47	56	25	8	12	-1	11	8	5	3	***	***	***	-15
840125	163241	3	65	62	62	61	53	61	27	8	13	-0	11	8	7	4	***	***	***	-15
840125	164328	3	68	74	74	61	65	68	31	25	22	18	7	6	4	2	***	71	85	-15
840125	164428	3	67	74	73	60	66	67	31	26	23	19	7	5	4	2	***	67	80	-15
840125	164528	3	67	74	72	59	66	66	30	26	23	20	6	5	3	1	***	63	76	-15
840125	164628	3	67	74	72	59	66	66	30	26	24	21	6	5	3	1	***	59	72	-15
840125	164828	3	66	74	71	58	66	64	29	25	25	23	6	4	2	0	***	52	64	-16
840125	165028	3	66	73	70	58	65	62	29	25	26	25	5	4	1	0	***	47	58	-16
840125	165228	3	65	72	69	57	65	61	28	25	26	27	5	3	0	-0	***	42	52	-16
840125	165428	3	64	71	68	57	64	59	28	25	27	29	4	3	0	-0	***	37	46	-16
840125	165701	3	64	70	67	56	63	58	28	25	28	30	4	2	-1	-1	***	32	40	-16
840125	165928	3	63	70	66	56	63	56	27	25	29	32	3	2	-1	-1	***	28	35	-16
840125	170228	3	62	68	64	55	62	55	27	25	30	33	3	1	-2	-1	***	23	30	-16
840125	170528	3	61	67	63	54	61	54	26	25	31	34	2	1	-3	-2	***	19	26	-16
840125	170828	3	61	66	62	53	60	53	26	25	31	34	2	1	-3	-2	***	16	22	-16
840125	171228	3	60	65	61	53	59	52	25	25	32	35	2	0	-3	-3	***	13	17	-16
840125	174144	3	51	56	54	46	52	46	23	23	33	34	-1	-1	-5	-4	***	-0	1	-16
840125	175618	3	47	51	51	43	49	43	21	22	32	32	-1	-2	-6	-5	***	-3	-3	-16
840125	181349	3	44	47	48	40	47	40	20	21	31	30	-2	-3	-8	-6	***	-5	-6	-16
840125	183313	3	40	43	45	37	44	37	18	20	30	28	-2	-4	-8	-7	***	-7	-8	-15
840125	185512	3	37	38	41	33	41	35	17	19	28	27	-3	-4	-9	-7	***	-8	-9	-15
840125	202514	3	25	25	30	23	30	25	10	13	20	19	-5	-5	-11	-9	***	-11	-11	-16
840125	211223	3	21	20	25	19	26	20	8	10	17	16	-5	-5	-11	-9	***	-11	-11	-15
840125	215626	3	17	16	21	16	22	17	6	7	14	13	-6	-6	-11	-10	***	-12	-12	-15

UNCLASSIFIED

UNCLASSIFIED

/C-9

Table C-2 (Cont'd)
THERMOCOUPLE TEMPERATURES

840125	224426	3	13	13	17	13	18	14	3	5	11	10	-	7	-	7	-12	-10	***	-12	-12	-15										
840125	234326	3	10	9	13	9	14	10	1	3	8	7	-	7	-	7	-12	-11	***	-12	-12	-14										
840126	005326	3	7	6	9	6	10	7	-	1	1	5	4	-	8	-	8	-12	-11	***	-12	-12	-13									
840126	022126	3	3	3	5	3	6	4	-	3	-	1	2	2	-	9	-	8	-12	-10	***	-12	-12	-12								
840126	041826	3	-	0	-	1	1	-	0	2	-	0	-	4	-	4	-	1	-	1	-	9	-	9	-12	-11	***	-12	-12	-13		
840126	065326	3	-	3	-	3	-	3	-	4	-	2	-	4	-	7	-	6	-	4	-	4	-	10	-	10	-12	-12	***	-12	-12	-12

UNCLASSIFIED

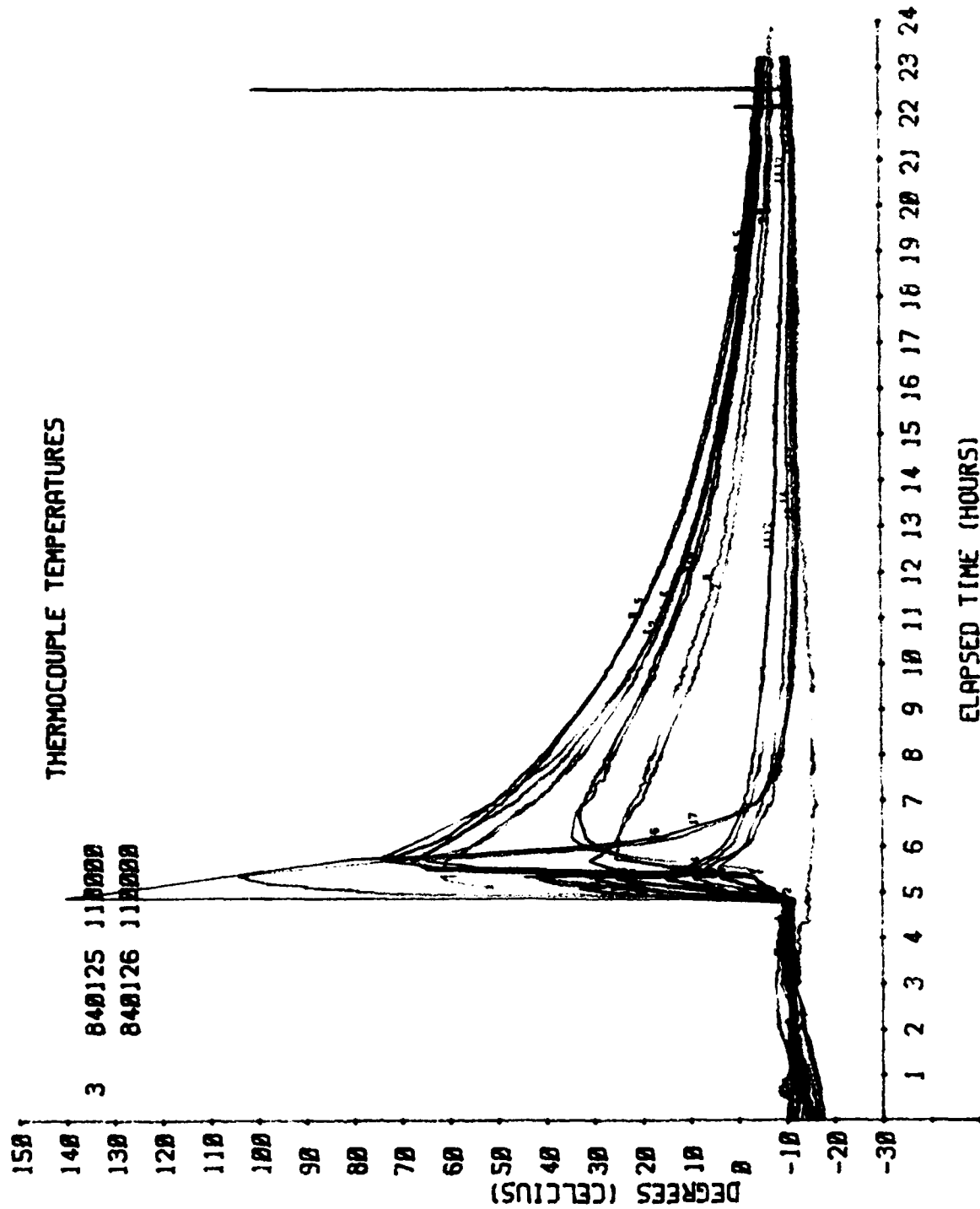


Figure C-2

UNCLASSIFIED

/C-11

Table C-3
THERMOCOUPLE TEMPERATURES

			THERMOCOUPLE TEMPERATURES																	
DATE	TIME	VEH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
840126	110658	3	- 6	- 6	- 6	- 6	- 5	- 6	- 8	- 8	- 7	- 7	- 10	- 9	- 9	- 8	***	-10	-10	- 8
840126	111436	3	26	23	20	18	- 0	19	- 2	- 6	- 3	- 8	- 9	- 9	- 9	- 9	***	-10	-10	- 8
840126	111636	3	31	28	26	25	5	26	- 2	- 5	- 1	- 7	- 9	- 9	- 9	- 9	***	-10	-10	- 9
840126	111836	3	37	33	31	30	11	31	0	- 4	- 0	- 5	- 9	- 8	- 9	- 9	***	-10	-10	- 8
840126	112940	3	55	53	51	50	39	50	11	3	7	1	- 9	- 8	- 9	- 9	***	-10	-10	- 9
840126	113240	3	59	57	55	54	45	54	11	3	9	2	- 9	- 9	- 9	- 8	***	-10	-10	- 9
840126	113340	3	60	59	56	54	49	55	10	3	10	3	- 8	- 8	- 9	- 9	***	-10	-10	- 9
840126	113640	3	62	60	57	55	53	56	13	4	12	4	- 9	- 8	- 8	- 9	***	-10	-10	-10
840126	114240	3	66	64	60	59	57	59	15	5	15	5	- 9	- 8	- 8	- 9	***	-10	-10	-10
840126	114840	3	69	68	64	62	61	63	20	8	17	7	- 8	- 8	- 8	- 9	***	- 9	-10	-10
840126	115140	3	69	70	64	63	61	63	22	13	18	7	- 9	- 8	- 7	- 6	***	- 9	- 9	-10
840126	115240	3	68	70	64	63	61	62	23	20	19	9	- 8	- 8	- 6	- 6	***	- 9	- 9	-10
840126	115440	3	66	70	64	62	61	61	24	20	20	13	- 8	- 7	- 7	- 6	***	- 9	- 9	-10
840126	115740	3	64	70	63	61	62	58	23	22	21	19	- 8	- 7	- 6	- 6	***	- 9	- 9	-10
840126	120116	3	62	68	62	59	61	55	22	22	22	24	- 8	- 8	- 6	- 6	***	- 9	- 9	-10
840126	120616	3	60	67	60	57	60	51	21	22	24	28	- 8	- 7	- 6	- 5	***	- 9	- 9	-10
840126	121616	3	57	64	57	53	57	47	20	21	25	32	- 8	- 7	- 6	- 5	***	- 9	- 9	-10
840126	122716	3	54	60	55	49	53	44	19	22	27	32	- 8	- 7	- 6	- 4	***	- 9	- 9	-11
840126	124116	3	51	55	52	45	50	40	18	20	27	31	- 8	- 7	- 6	- 4	***	- 9	- 8	-11
840126	125610	3	47	51	49	40	47	38	17	19	27	30	- 8	- 7	- 6	- 4	***	- 9	- 8	-10
840126	131451	3	43	46	45	36	44	34	15	18	26	28	- 8	- 7	- 5	- 4	***	- 9	- 8	- 9
840126	133309	3	39	42	42	33	40	32	14	17	24	26	- 8	- 7	- 5	- 5	***	- 9	- 8	-11
840126	161054	3	18	19	21	15	21	16	4	7	12	13	- 8	- 8	- 8	- 7	***	-10	-10	-15
840126	163920	3	15	15	18	13	18	13	2	5	10	10	- 9	- 9	- 9	- 8	***	-11	-11	-17
840126	172020	3	12	12	14	9	14	10	- 0	2	7	7	-10	-10	-11	-10	***	-12	-12	-18
840126	180820	3	8	9	10	6	11	6	- 3	- 1	4	4	-11	-11	-13	-12	***	-14	-13	-18
840126	220016	3	- 3	- 2	- 2	- 4	- 1	- 4	- 9	- 8	- 5	- 5	-14	-15	-18	-17	***	-18	-18	-21
840127	001605	3	- 6	- 6	- 6	- 7	- 5	- 8	-12	-10	- 8	- 8	-15	-16	-20	-18	***	-19	-20	-24
840127	013505	3	- 9	- 9	- 9	- 9	- 8	-10	-14	-12	-10	-11	-17	-18	-21	-20	24	-21	-21	-23
840127	045405	3	-12	-12	-13	-13	-12	-13	-16	-15	-14	-14	-18	-19	-21	-20	***	-21	-21	-21

UNCLASSIFIED

UNCLASSIFIED

/C-12

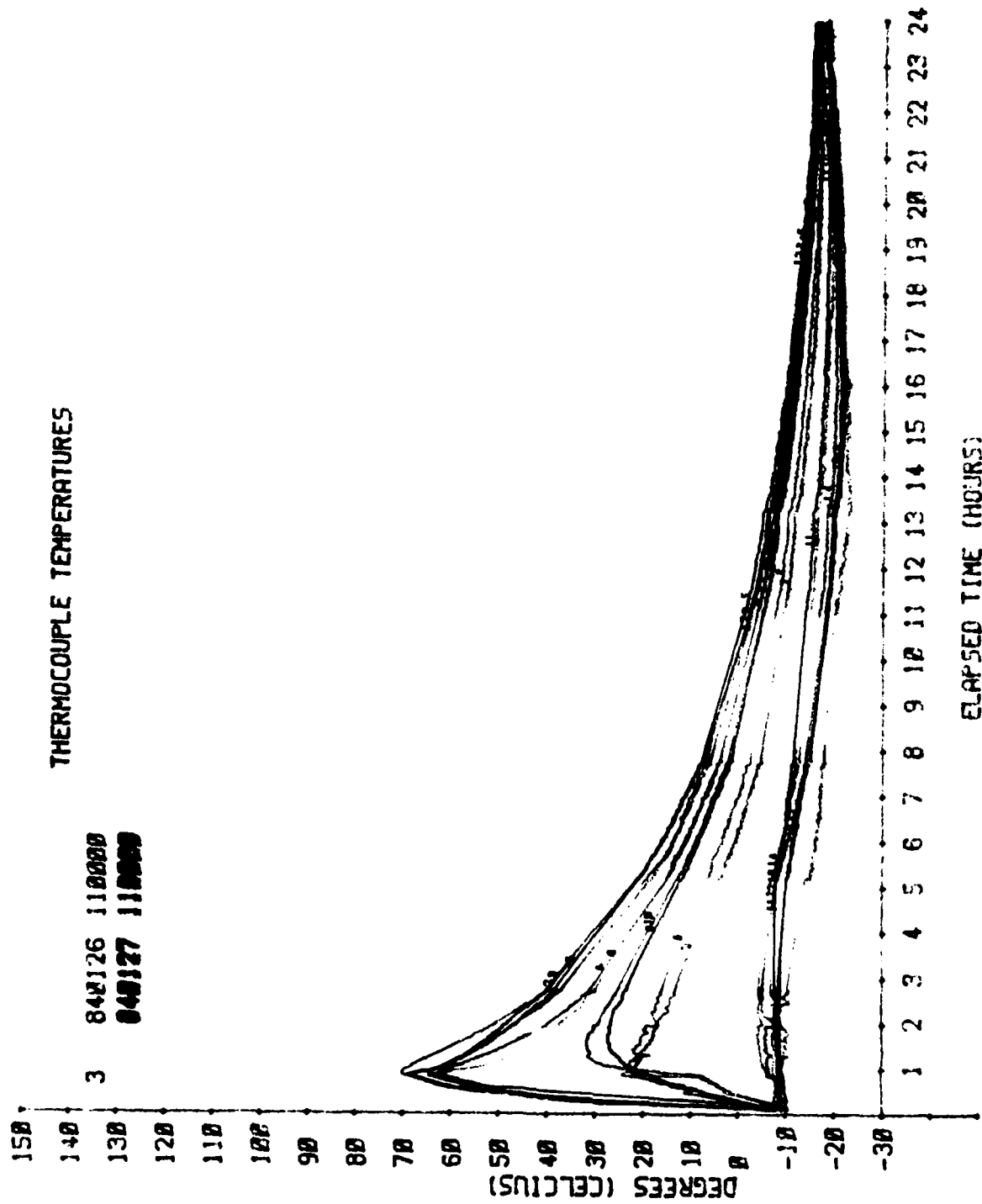


Figure C-3

UNCLASSIFIED

UNCLASSIFIED

/C-13

Table C-4

THERMOCOUPLE TEMPERATURES

			THERMOCOUPLE TEMPERATURES																	
DATE	TIME	VEH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
840127	103011	3	-15	-15	-16	-15	-15	-16	-16	-16	-16	-16	-18	-18	-17	-18	***	-18	-18	-16
840127	114849	3	-15	-16	-16	-16	-16	-16	-16	-16	-16	-17	-17	-17	-16	-14	***	-17	-18	-15
840127	115349	3	-14	-15	-16	-16	-15	-16	-11	-15	-16	-16	-15	-15	-13	-14	***	-16	-17	-15
840127	115449	3	-14	-15	-15	-15	-15	-16	-3	-11	-15	-16	-14	-15	-13	-14	***	-16	-17	-15
840127	115649	3	-13	-14	-14	-15	-15	-15	3	-6	-15	-15	-14	-13	-11	-14	***	-8	76	-15
840127	115749	3	-11	-12	-14	-15	-14	-15	4	-3	-14	-14	-14	-8	-9	-14	***	5	***	-15
840127	115849	3	-10	-10	-13	-14	-14	-15	6	-1	-14	-13	-13	-2	-4	-13	***	19	***	-15
840127	115949	3	-9	-8	-13	-14	-14	-15	7	-1	-13	-13	-11	5	0	-12	***	33	***	-15
840127	120049	3	-8	-5	-13	-13	-13	-15	8	1	-12	-12	-9	11	5	-11	***	45	***	-15
840127	120149	3	-7	-2	-13	-13	-13	-14	9	2	-11	-11	-7	17	9	-9	***	56	***	-15
840127	120306	3	-5	2	-12	-11	-12	-13	11	3	-8	-10	-4	23	14	-8	***	69	***	-15
840127	120356	3	-4	4	-12	-12	-12	-13	12	4	-7	-9	-3	26	17	-7	***	74	***	-15
840127	120456	3	-3	7	-11	-11	-12	-13	13	5	-4	-8	-1	30	19	-6	***	79	***	-15
840127	120656	3	-1	11	-9	-11	-11	-12	15	8	-1	-6	2	36	24	-4	***	85	***	-15
840127	120858	3	0	15	-8	-10	-11	-11	17	10	2	-5	5	41	27	-2	***	89	***	-15
840127	121058	3	2	18	-7	-9	-10	-10	17	10	4	-3	8	44	29	-1	***	93	***	-15
840127	121358	3	4	23	-5	-9	-9	-8	16	13	8	-1	12	46	30	-5	***	95	***	-15
840127	121604	3	5	25	-5	-7	-9	-9	18	14	3	-4	13	47	31	-2	***	95	***	-15
840127	122004	3	6	29	-4	-6	-8	-5	17	15	10	0	13	49	33	1	***	95	***	-15
840127	122104	3	5	29	-4	-7	-8	-7	19	16	3	-3	13	50	34	4	***	95	***	-15
840127	122204	3	6	27	-4	-6	-7	-4	19	17	8	0	12	50	34	0	***	96	***	-15
840127	122404	3	6	16	-3	-5	-6	-3	18	17	14	2	13	50	33	-3	***	96	***	-15
840127	122504	3	7	26	-3	-5	-6	-2	19	17	15	3	13	51	34	-2	***	96	***	-15
840127	122726	3	10	32	-2	-4	-5	-0	20	18	17	5	14	51	34	-3	***	97	***	-15
840127	122926	3	11	36	-1	-4	-4	1	19	17	19	6	14	52	34	-2	***	97	***	-15
840127	123251	3	13	41	0	-4	-4	4	21	18	20	7	16	52	35	-2	***	97	***	-15
840127	123635	3	15	19	-1	-0	-3	-1	20	17	11	3	18	54	36	3	***	98	***	-15
840127	123735	3	18	19	5	5	-2	5	12	10	10	-2	17	35	25	2	***	***	***	-15
840127	123835	3	22	20	10	10	-1	10	7	7	7	-6	15	22	9	0	***	***	***	-15
840127	123935	3	21	19	10	10	1	11	9	7	8	-5	13	17	5	-0	***	***	***	-14
840127	124635	3	***	***	***	***	***	***	***	***	5	-6	8	7	***	***	***	***	***	-15
840127	124735	3	44	41	36	34	21	35	13	4	6	-6	7	7	-5	-7	***	***	***	-15
840127	124835	3	48	47	39	38	30	38	15	3	5	-5	7	6	-5	-7	***	***	***	-14
840127	124951	3	54	55	46	45	38	45	15	5	5	-6	6	5	-6	-7	***	98	***	-14
840127	125051	3	58	58	51	50	44	50	19	6	6	-5	6	5	-7	-7	***	91	***	-14
840127	125151	3	62	61	56	55	49	55	23	7	7	-4	5	5	-8	-8	***	85	***	-14
840127	125251	3	65	64	61	60	54	60	25	8	9	-3	5	4	-8	-8	***	80	94	-14
840127	125351	3	69	67	66	65	59	65	23	9	10	-2	5	3	-8	-7	***	75	87	-15
840127	125451	3	72	69	71	69	63	69	27	11	11	-1	4	2	-8	-8	***	70	80	-14
840127	125551	3	76	74	75	74	68	74	29	11	13	1	4	2	-9	-8	***	66	73	-14
840127	125651	3	74	76	75	73	62	72	31	15	14	1	3	2	-8	-7	***	62	59	-14
840127	125751	3	73	77	75	70	61	74	31	18	15	3	3	0	-6	-7	***	57	59	-14
840127	125851	3	72	76	75	66	62	74	31	16	17	5	3	0	-4	-7	***	53	55	-14
840127	130051	3	70	75	75	61	64	67	30	21	18	10	3	0	-4	-6	***	48	51	-14
840127	130251	3	69	74	74	58	65	65	30	21	20	14	3	0	-4	-6	***	43	45	-14
840127	130451	3	68	74	73	57	66	63	29	18	22	17	2	0	-4	-6	***	37	38	-14
840127	130651	3	67	74	72	56	66	62	28	18	24	19	2	0	-4	-6	***	34	34	-14
840127	130851	3	66	74	71	56	66	60	27	12	27	20	2	-0	-4	-6	***	30	28	-14
840127	130951	3	66	73	70	56	66	59	27	18	27	21	2	-0	-4	-6	***	28	28	-14
840127	153055	3	31	33	34	24	32	23	8	10	21	19	-4	-6	-10	-9	***	-10	-10	-14
840127	155416	3	27	29	30	22	29	20	6	8	19	17	-4	-6	-10	-9	***	-11	-11	-14
840127	162311	3	23	25	26	18	25	16	4	6	16	14	-5	-7	-10	-10	***	-11	-11	-13
840127	165523	3	19	20	22	15	21	14	2	4	14	12	-6	-8	-11	-11	***	-12	-11	-13
840127	173123	3	15	17	18	12	17	11	0	3	11	9	-7	-8	-11	-11	***	-12	-12	-13
840127	181758	3	12	13	14	8	13	9	-1	1	7	7	-7	-8	-10	-11	***	-11	-12	-13
840127	182347	3	11	12	13	8	13	8	-1	-0	7	6	***	-12	-12	-11	***	-11	-12	-13
840127	183750	3	10	11	12	7	12	7	-1	-1	6	5	9	-12	-11	-11	***	-11	-12	-13
840127	193624	3	7	7	8	5	8	5	-3	-1	3	3	8	-12	-11	-11	***	-12	-12	-12
840127	205154	3	4	4	4	2	5	2	-4	-2	1	1	4	-11	-11	-11	***	-12	-12	-12

UNCLASSIFIED

UNCLASSIFIED

/C-14

Table C-4 (Cont'd)
THERMOCOUPLE TEMPERATURES

840127	225908	3	0	-	0	-	0	-	1	1	-	1	-	4	-	4	-	2	-	1	0	-	10	-	10	-	10	***	-	11	-	11	-	10			
840128	020941	3	-	3	-	3	-	3	-	4	-	3	-	4	-	7	-	7	-	5	-	5	-	3	-	11	-	11	-	10	***	-	11	-	11	-	13
840128	080051	3	-	7	-	7	-	7	-	7	-	6	-	8	-	9	-	9	-	8	-	8	-	8	-	12	-	11	-	11	***	-	12	-	12	-	12

UNCLASSIFIED

UNCLASSIFIED

/C-15

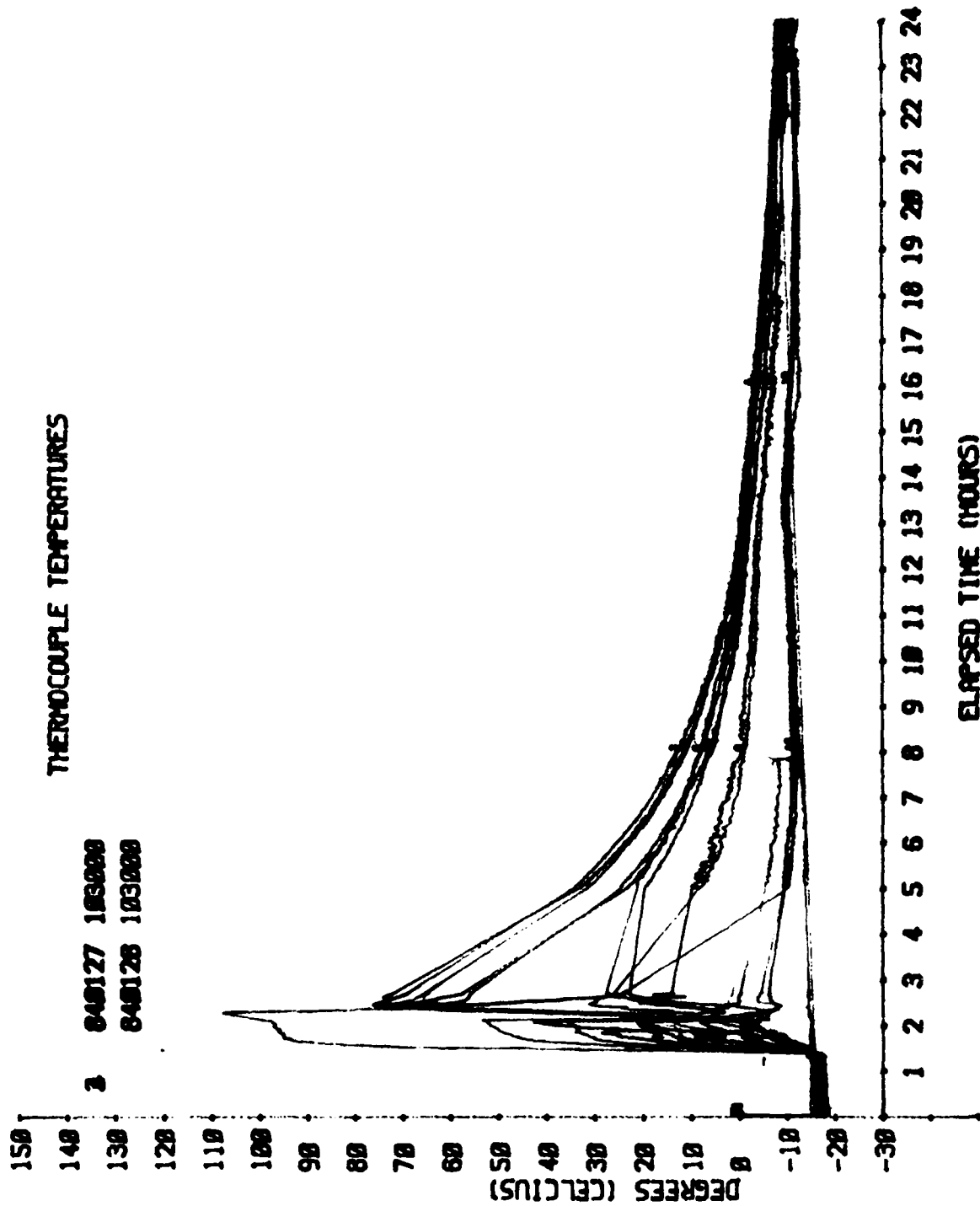


Figure C-4

UNCLASSIFIED

UNCLASSIFIED

/C-16

Table C-5

THERMOCOUPLE TEMPERATURES

			THERMOCOUPLE TEMPERATURES																	
DATE	TIME	VEH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
840128	103021	3	-8	-8	-8	-8	-8	-9	-10	-10	-9	-9	-9	-11	-11	-11	***	-11	-12	-11
840128	110250	3	-8	-8	-8	-9	-8	-9	-6	-8	-9	-9	-8	-9	-7	-8	***	-10	-11	-10
840128	110350	3	-8	-8	-8	-8	-8	-9	-2	-4	-9	-9	-8	-8	-5	-8	***	-9	9	-10
940128	110450	3	-7	-8	-8	-8	-8	-8	0	-0	-9	-9	-8	-3	-5	-9	***	-1	***	-10
840128	110550	3	-7	-8	-8	-8	-8	-6	2	2	-9	-8	-7	4	-1	-8	***	10	***	-10
840128	110650	3	-6	-7	-8	-7	-7	-5	3	3	-8	-7	-5	13	3	-7	***	24	***	-10
840128	110750	3	-5	-6	-8	-7	-7	-3	5	5	-7	-6	-4	21	9	-6	***	39	***	-10
840128	110850	3	-4	-4	-7	-6	-7	-2	5	7	-5	-5	-2	29	14	-5	***	53	***	-10
840128	110950	3	-3	-0	-7	-6	-6	-1	6	8	-3	-5	0	36	18	-4	***	63	***	-10
840128	111037	3	-2	0	-6	-6	-6	0	8	10	-2	-4	2	40	21	-3	***	70	***	-9
840128	111117	3	-2	1	-6	-6	-6	1	8	10	-0	-3	4	44	24	-2	***	75	***	-9
840128	111217	3	-1	4	-6	-5	-6	2	9	11	2	-2	6	48	26	-2	***	82	***	-9
840128	111417	3	0	8	-5	-4	-5	4	11	13	6	-0	11	54	31	-2	***	88	***	-9
840128	111512	3	0	12	-5	-4	-5	5	10	13	8	0	13	57	32	-1	***	91	***	-10
940128	111712	3	2	14	-4	-4	-5	6	11	16	11	2	16	60	36	-0	***	95	***	-9
840128	112012	3	4	17	-3	-3	-5	9	14	18	15	4	21	63	38	1	***	97	***	-9
840128	112528	3	6	25	-1	-2	-4	11	15	17	19	6	27	67	41	2	***	***	***	-9
840128	112917	3	8	27	-0	-1	-3	12	16	20	21	7	29	69	43	7	***	***	***	-10
840128	113417	3	9	32	1	-1	-2	14	18	22	23	8	32	71	44	7	***	***	***	-9
840128	113831	3	11	36	2	-1	-1	14	19	24	24	9	34	72	46	7	***	***	***	-9
840128	114345	3	13	40	3	-0	0	16	22	26	25	11	36	72	46	9	***	***	***	-9
840128	114745	3	16	45	4	1	1	16	24	28	26	12	38	72	47	10	***	***	***	-9
840128	115245	3	18	50	6	2	3	17	25	30	27	14	39	72	47	11	***	98	***	-9
840128	115745	3	20	55	7	3	5	18	26	31	28	15	40	72	48	12	***	***	***	-8
840128	120135	3	22	59	9	4	6	19	28	32	29	16	40	72	48	12	***	98	***	-8
840128	120835	3	24	63	11	5	8	21	28	33	31	18	41	73	49	11	***	***	***	-9
840128	121255	3	25	66	11	6	8	21	4	22	31	18	40	51	19	8	***	***	***	-9
840128	121355	3	25	66	11	6	9	21	5	18	31	17	37	36	9	6	***	***	***	-9
840128	121555	3	24	65	10	5	9	18	5	16	29	15	33	31	7	4	***	***	***	-9
840128	121655	3	24	65	10	5	9	17	2	19	28	15	31	26	4	3	***	***	***	-9
840128	121755	3	24	65	9	5	9	16	6	19	27	14	29	25	4	3	***	***	***	-9
840128	121855	3	24	64	9	5	9	16	2	18	26	14	28	24	4	3	***	***	***	-9
840128	122055	3	24	64	9	5	9	14	6	19	24	13	25	20	1	1	***	***	***	-9
840128	122355	3	24	63	9	5	9	14	5	20	23	12	22	15	-1	0	***	***	***	-8
840128	122455	3	24	62	9	5	10	14	5	21	23	12	21	15	0	1	***	***	96	-8
840128	122612	3	24	62	9	5	9	14	6	20	22	12	20	14	-1	-0	***	***	86	-8
840128	122712	3	25	61	9	5	10	14	5	20	22	12	19	13	-0	-0	***	***	78	-8
840128	122812	3	24	61	9	5	10	14	2	18	22	12	19	12	-0	-0	***	***	70	-8
840128	122912	3	24	61	8	5	10	14	-2	16	21	12	18	12	-0	-0	***	***	62	-9
840128	123012	3	24	60	8	5	9	13	2	15	21	11	17	12	-1	-1	***	97	57	-10
840128	123112	3	24	60	8	5	10	13	-1	12	21	11	17	12	0	-1	***	93	51	-9
840128	123327	3	24	59	8	5	10	12	0	13	19	11	16	11	-1	-2	***	86	43	-9
840128	123527	3	24	58	8	6	10	11	1	15	18	10	15	9	-2	-2	***	78	37	-8
840128	123627	3	24	58	8	6	10	10	1	13	18	10	15	9	-1	-2	***	75	33	-8
840128	123827	3	24	57	7	6	9	10	-3	10	17	10	14	9	-1	-2	***	69	26	-10
840128	124027	3	24	56	7	6	9	9	-2	9	17	9	14	9	-1	-2	***	63	23	-9
840128	124127	3	24	55	7	6	9	8	3	12	16	9	14	7	-3	-3	***	61	22	-8
840128	124236	3	24	55	7	6	9	8	-2	11	15	9	13	7	-3	-1	***	58	18	-9
840128	124436	3	23	54	7	6	9	8	1	13	15	8	13	6	-4	-3	***	53	16	-8
840128	124636	3	23	53	7	6	9	7	1	12	14	8	12	5	-4	-3	***	49	12	-8
840128	125153	3	19	51	7	6	9	8	-2	9	14	8	12	4	-4	-4	***	39	5	-9
840128	125353	3	18	50	6	6	9	7	2	15	13	7	11	3	-5	-4	***	35	5	-8
840128	125653	3	18	49	6	6	9	8	2	15	13	8	10	2	-6	-5	***	31	2	-8
840128	130053	3	17	48	6	6	9	9	1	16	13	9	10	1	-5	-2	***	26	-1	-8
840128	130457	3	17	46	6	6	9	9	-0	15	14	9	9	1	-6	-5	***	22	-2	-7
840128	130957	3	17	44	6	6	9	9	2	16	14	9	9	1	-6	-5	***	17	-3	-8
840128	131257	3	17	44	6	6	9	9	-3	13	14	9	8	0	-7	-5	***	13	-4	-8
840128	131357	3	16	43	6	6	9	9	2	15	14	9	8	0	-6	-5	***	13	-4	-8
840128	131457	3	16	43	6	6	9	9	-3	12	14	9	8	0	-6	-5	***	12	-5	-8

UNCLASSIFIED

UNCLASSIFIED
Table C-5 (Cont'd)

/C-17

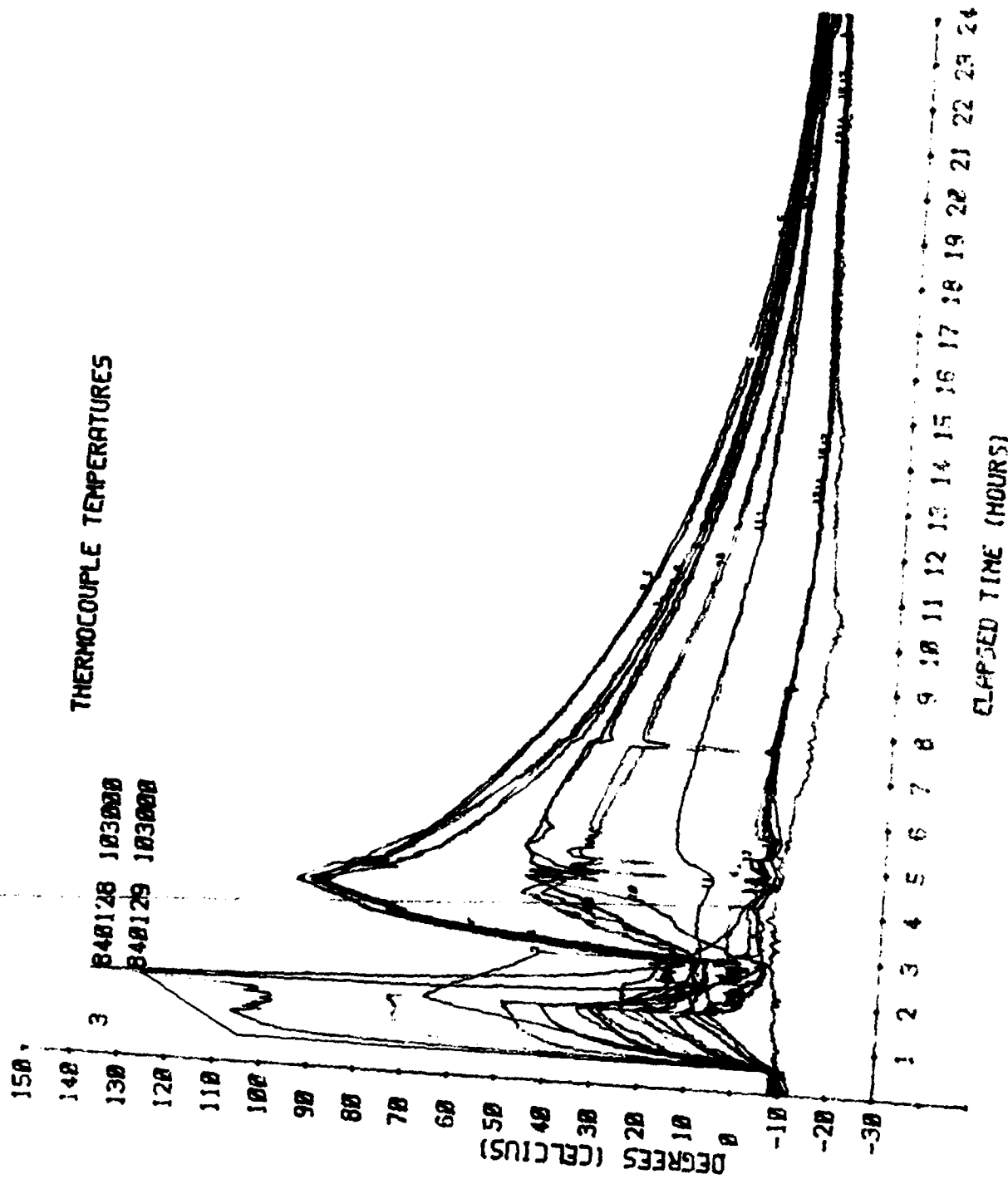
THERMOCOUPLE TEMPERATURES

840128	131800	3	16	42	6	6	9	8	5	13	13	9	8	-	0	-	6	-	5	***	12	-	5	-	7		
840128	132132	3	17	42	6	6	9	9	5	17	13	10	8	-	0	-	5	-	4	***	12	-	5	-	7		
840128	132232	3	17	29	7	7	8	7	4	14	10	21	7	-	1	-	5	-	5	***	11	-	6	-	7		
840128	132332	3	20	25	11	11	8	11	0	15	8	25	7	-	1	-	7	-	6	***	10	-	5	-	7		
840128	132432	3	24	24	15	15	9	15	6	14	8	15	8	-	1	-	6	-	6	***	9	-	5	-	7		
840128	132532	3	27	25	19	19	9	19	10	13	9	6	7	-	1	-	6	-	5	***	9	-	6	-	7		
840128	132632	3	29	26	23	22	11	23	10	13	9	2	7	-	1	-	5	-	5	***	10	-	6	-	7		
840128	132832	3	34	30	29	28	14	28	11	13	9	-	0	8	2	-	3	-	5	***	10	-	5	-	8		
840128	133410	3	43	40	39	39	27	39	14	14	10	1	8	2	-	3	-	1	***	8	-	5	-	7			
840128	133510	3	46	44	37	34	29	37	15	13	10	2	8	3	-	1	-	0	***	8	-	5	-	7			
840128	133710	3	51	49	40	38	34	39	16	13	12	2	8	2	-	2	-	5	***	8	-	5	-	7			
840128	133910	3	52	51	44	42	39	43	18	13	12	2	8	2	-	3	-	5	***	7	-	5	-	7			
840128	134210	3	55	56	49	47	43	48	20	14	14	3	8	2	-	3	-	5	***	6	-	5	-	8			
840128	134410	3	58	58	52	51	48	52	21	17	14	5	8	2	-	3	-	6	***	5	-	5	-	9			
840128	134710	3	62	62	57	55	53	56	23	16	16	6	8	2	-	3	-	5	***	5	-	5	-	7			
840128	135010	3	65	65	61	59	57	60	25	17	17	7	8	2	-	3	-	5	***	4	-	5	-	7			
840128	135310	3	68	69	64	63	60	64	24	17	19	9	9	2	-	2	-	4	***	4	-	5	-	7			
840128	135510	3	70	70	67	65	63	66	28	22	20	10	9	2	-	2	-	5	***	3	-	4	-	8			
840128	135910	3	74	74	70	69	67	70	31	23	21	11	9	2	-	3	-	5	***	2	-	4	-	9			
840128	140310	3	77	78	74	72	70	73	32	23	23	12	9	1	-	3	-	5	***	2	-	4	-	8			
840128	141010	3	80	81	75	73	73	73	35	28	25	13	9	2	-	3	-	6	***	1	-	4	-	8			
840128	141610	3	83	84	79	78	77	78	36	30	26	14	8	2	-	2	-	5	***	-	0	-	4	-	8		
840128	142210	3	86	86	83	81	80	82	40	34	29	16	8	2	-	2	-	5	***	-	1	-	4	-	6		
840128	143010	3	90	90	87	86	84	86	42	37	32	19	8	2	-	2	-	4	***	-	1	-	4	-	8		
840128	143810	3	94	93	91	89	88	90	47	42	34	20	8	1	-	4	-	3	***	-	1	-	4	-	7		
840128	143910	3	92	93	90	89	87	90	45	42	35	22	8	0	-	5	-	3	-	3	-	2	-	5	-	8	
840128	145911	3	83	87	83	78	82	75	39	37	45	45	6	-	1	-	6	-	4	-	6	-	5	-	6	-	7
840128	150207	3	83	87	80	73	81	78	40	40	40	30	6	-	1	-	4	-	0	-	6	-	5	-	7	-	8
840128	150307	3	83	83	77	75	78	76	39	37	37	32	6	-	3	-	8	-	6	-	6	-	5	-	7	-	8
840128	150507	3	81	83	78	74	78	74	38	34	42	33	6	-	3	-	8	-	8	-	6	-	5	-	7	-	7
840128	151046	3	81	80	75	73	76	73	37	38	37	31	6	-	2	-	5	-	6	-	6	-	5	-	7	-	8
840128	151146	3	79	79	75	73	76	72	20	34	40	32	6	-	1	-	3	-	5	-	3	-	6	-	7	-	8
840128	151433	3	76	79	75	70	75	70	29	32	43	36	6	-	1	-	4	-	4	-	5	-	5	-	7	-	8
840128	151533	3	75	79	75	70	75	69	35	33	43	37	***	-	1	-	5	-	5	-	5	-	5	-	7	-	8
840128	152017	3	73	78	75	69	74	68	36	33	45	40	6	2	-	5	-	6	-	6	-	6	-	7	-	8	
840128	152948	3	70	75	72	65	71	65	19	31	44	43	10	9	-	2	-	4	-	2	-	5	-	7	-	8	
840128	153048	3	70	75	72	65	71	64	31	34	45	44	11	10	-	2	-	3	-	4	-	5	-	7	-	8	
840128	153758	3	69	72	70	63	69	63	35	37	45	46	12	11	-	2	-	3	-	4	-	5	-	7	-	9	
840128	154457	3	67	70	68	62	67	61	33	33	45	45	13	12	-	6	-	5	-	5	-	5	-	6	-	9	
840128	155717	3	64	66	66	59	65	58	32	32	44	42	14	12	-	7	-	6	-	7	-	7	-	8	-	9	
840128	161137	3	60	62	63	56	62	55	31	32	43	41	14	12	-	3	-	5	-	6	-	7	-	8	-	10	
840128	162829	3	57	58	60	52	59	53	30	32	42	42	14	12	-	3	-	4	-	5	-	6	-	7	-	10	
840128	171125	3	48	48	53	45	52	46	26	29	39	38	13	11	-	4	-	4	-	4	-	5	-	6	-	10	
840128	173124	3	45	44	50	42	49	43	24	28	37	36	12	10	-	4	-	5	-	5	-	6	-	6	-	13	
840128	175724	3	41	40	46	38	46	40	23	26	34	33	11	10	-	5	-	5	-	5	-	6	-	6	-	13	
840128	180324	3	40	39	46	38	45	40	13	24	34	33	11	10	-	5	-	6	-	5	-	6	-	6	-	14	
840128	180424	3	40	39	45	37	45	39	5	19	34	32	11	9	-	5	-	6	-	5	-	6	-	6	-	13	
840128	181011	3	38	38	44	35	44	37	17	20	32	29	11	9	-	5	-	6	-	5	-	6	-	6	-	13	
840128	181425	3	37	37	44	35	43	37	22	23	31	29	10	9	-	6	-	6	-	5	-	6	-	6	-	13	
840128	184546	3	34	33	40	32	40	34	20	21	29	28	9	8	-	7	-	7	-	6	-	7	-	7	-	13	
840128	192244	3	30	29	35	28	36	30	18	19	26	25	8	7	-	7	-	8	-	7	-	8	-	8	-	14	
840128	200130	3	26	25	32	25	32	27	15	16	23	22	6	6	-	9	-	9	***	-	9	-	9	-	15		
840128	204318	3	23	22	27	22	28	23	13	14	20	19	5	4	-	10	-	10	***	-	9	-	10	-	17		
840128	213421	3	19	18	23	18	24	19	10	11	17	15	3	3	-	11	-	11	***	-	11	-	11	-	16		
840128	225657	3	13	12	16	12	***	13	5	6	11	***	-	0	0	-	12	-	12	***	-	12	-	12	-	15	
840128	231210	3	12	12	15	11	-	0	12	5	5	10	***	-	0	-	0	-	12	-	12	***	-	12	-	15	
840128	231310	3	13	12	15	11	***	12	5	5	10	1	-	0	-	0	-	12	-	12	***	-	12	-	16		
840128	231422	3	13	12	16	11	***	12	5	5	10	***	-	0	0	-	12	-	12	1	-	12	-	12	-	15	
840128	231638	3	12	12	15	11	***	12	5	6	10	10	-	0	0	-	12	-	12	***	-	12	-	12	-	15	
840128	231738	3	13	12	15	11	16	12	5	6	10	10	-	0	0	-	12	-	12	***	-	12	-	12	-	15	
840129	002138	3	9	9	11	8	13	9	2	3	7	7	-														

UNCLASSIFIED

UNCLASSIFIED

/C-18



UNCLASSIFIED

figure C-5

Table C-6

THERMOCOUPLE TEMPERATURES

			THERMOCOUPLE TEMPERATURES -																	
DATE	TIME	VEH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
840129	103044	3	-6	-6	-6	-6	-5	-7	-8	-9	-7	-7	-9	-10	-11	-12	***	-11	-11	-12
840129	104444	3	0	-2	-3	-4	-6	-4	-5	-8	-7	-9	-9	-10	-11	-11	***	-11	-12	-12
840129	104544	3	9	5	1	1	-6	1	-5	-8	-7	-10	-10	-10	-11	-11	***	-11	-12	-12
840129	104644	3	13	10	5	5	-5	5	-5	-8	-6	-9	-9	-10	-11	-11	***	-11	-12	-12
840129	104744	3	17	13	9	9	-4	9	-4	-7	-6	-9	-9	-10	-11	-11	***	-11	-12	-12
840129	104944	3	23	19	16	15	-1	16	-3	-6	-5	-8	-9	-9	-11	-12	***	-11	-12	-11
840129	105144	3	26	21	18	15	3	17	-2	-5	-5	-7	-10	-10	-11	-11	***	-11	-12	***
840129	105344	3	32	27	24	22	8	23	-1	-4	-3	-6	-9	-9	-11	-11	***	-11	-12	-11
840129	105544	3	37	30	29	27	13	29	0	-3	-2	-5	-10	-10	-11	-11	***	-12	-12	-11
840129	105744	3	41	33	34	33	18	33	2	-2	-1	-4	-10	-10	-12	-12	***	-12	-12	-11
840129	105907	3	44	40	37	35	22	36	2	-1	-0	-3	-9	-9	-11	-11	***	-11	-12	-12
840129	110107	3	47	44	41	40	26	40	6	1	1	-2	-9	-9	-11	-11	***	-11	-12	-11
840129	110307	3	51	49	45	44	31	44	7	3	2	-1	-9	-9	-11	-11	***	-11	-12	-11
840129	110607	3	54	53	50	48	37	49	9	4	4	1	-9	-9	-11	-11	***	-11	-12	-11
840129	110910	3	57	57	54	52	43	53	11	6	6	2	-9	-9	-11	-11	***	-11	-12	-11
840129	111110	3	60	60	57	55	49	55	13	8	7	3	-9	-9	-11	-11	***	-11	-12	-12
840129	111357	3	63	63	60	58	54	59	15	9	8	5	-9	-9	-10	-11	***	-11	-11	-11
840129	112816	3	77	75	74	72	70	73	26	14	15	9	-9	-9	-10	-10	***	-11	-11	-11
840129	112916	3	77	78	72	68	70	71	27	18	16	8	-9	-9	-10	-10	***	-11	-11	-11
840129	113516	3	79	79	74	72	72	73	28	23	19	10	-9	-9	-10	-11	***	-11	-11	-11
840129	113816	3	79	80	75	74	72	74	32	26	20	11	-9	-9	-10	-10	***	-11	-11	-11
840129	114116	3	76	79	75	72	72	72	34	27	23	16	-9	-9	-10	-10	***	-10	-11	-11
840129	114316	3	75	78	75	72	72	71	33	27	25	20	-9	-9	-9	-10	***	-10	-11	-12
840129	114622	3	73	78	74	71	72	68	32	27	26	25	-9	-9	-9	-10	***	-10	-11	-11
840129	115011	3	72	77	72	68	71	66	31	26	28	29	-9	-8	-9	-10	***	-10	-11	-11
840129	115611	3	70	75	70	66	69	62	29	26	30	33	-8	-9	-9	-10	***	-10	-11	-10
840129	120509	3	66	72	67	63	66	58	28	25	33	35	-8	-9	-9	-10	***	-10	-10	-10
840129	121657	3	63	67	64	60	63	54	27	22	34	34	-8	-8	-8	-9	***	-10	-10	-11
840129	122957	3	59	63	61	56	60	52	26	23	35	34	-8	-8	-8	-9	***	-9	-10	-11
840129	124257	3	56	59	58	52	57	49	25	22	34	32	-8	-8	-8	-9	***	-9	-10	-11
840129	125757	3	52	55	55	48	54	46	24	21	33	32	-8	-8	-8	-9	***	-9	-10	-11
840129	131457	3	49	51	52	44	51	43	23	20	32	29	-8	-8	-8	-9	***	-9	-10	-10
840129	133157	3	45	47	49	41	48	40	22	18	30	26	-8	-8	-9	-9	***	-9	-9	-9
840129	135157	3	42	43	45	37	45	37	20	15	29	23	-8	-8	-8	-8	***	-9	-9	-10
840129	141357	3	38	38	42	34	41	34	18	14	26	21	-8	-8	-8	-8	***	-9	-10	-11
840129	143928	3	34	34	38	31	38	31	16	13	24	20	-8	-8	-8	-8	***	-9	-9	-11
840129	150754	3	30	30	34	27	34	28	15	12	22	18	-8	-8	-7	-8	***	-9	-9	-10
840129	154307	3	26	26	30	24	31	25	13	9	19	16	-8	-7	-7	-7	***	-8	-9	-11
840129	160215	3	1	24	28	22	29	***	12	9	18	14	***	-7	-8	-8	***	***	-9	-10
840129	160440	3	***	24	28	22	28	1	12	9	18	14	***	-7	-8	-8	***	***	-9	-9
840129	160534	3	***	24	28	22	28	***	11	9	18	14	1	-8	-8	-8	***	***	-9	-10
840129	160712	3	***	24	28	22	28	***	11	8	17	14	***	-7	-7	-8	***	1	-9	-10
840129	161211	3	1	23	27	22	28	***	11	8	17	13	***	-8	-8	-8	***	***	-9	-10
840129	163249	3	***	21	25	20	26	***	10	8	16	13	***	-8	-8	-8	***	98	-9	-11
840129	163715	3	22	21	25	20	25	20	10	8	16	13	-7	-7	-8	-8	***	-8	-9	-11
840129	172325	3	18	17	21	16	22	17	7	6	13	10	-8	-8	-9	-9	***	-9	-10	-11
840129	175425	3	16	15	18	14	19	14	5	2	10	7	-8	-9	-9	-9	***	-10	-10	-12
840129	185227	3	12	11	14	11	15	11	3	0	7	4	-9	-9	-10	-10	***	-10	-10	-13
840129	204510	3	7	6	7	6	9	6	-1	-3	2	-1	-10	-10	-11	-11	***	-11	-11	-13
840129	223337	3	2	2	3	1	4	1	-4	-6	-1	-4	-11	-11	-12	-12	***	-12	-12	-14
840130	001259	3	-1	-1	-1	-2	-0	-2	-6	-6	-4	-3	-12	-12	-14	-14	***	-14	-14	-18
840130	024659	3	-5	-5	-5	-6	-4	-6	-9	-9	-7	-7	-15	-14	-16	-16	***	-16	-16	-21
840130	054259	3	-9	-8	-9	-9	-8	-10	-13	-12	-10	-11	-17	-17	-19	-19	***	-19	-19	-24
840130	092936	3	-13	-12	-13	-13	-12	-14	-15	-15	-13	-14	-17	-18	-18	-19	***	-19	-20	-17

UNCLASSIFIED

/C-20

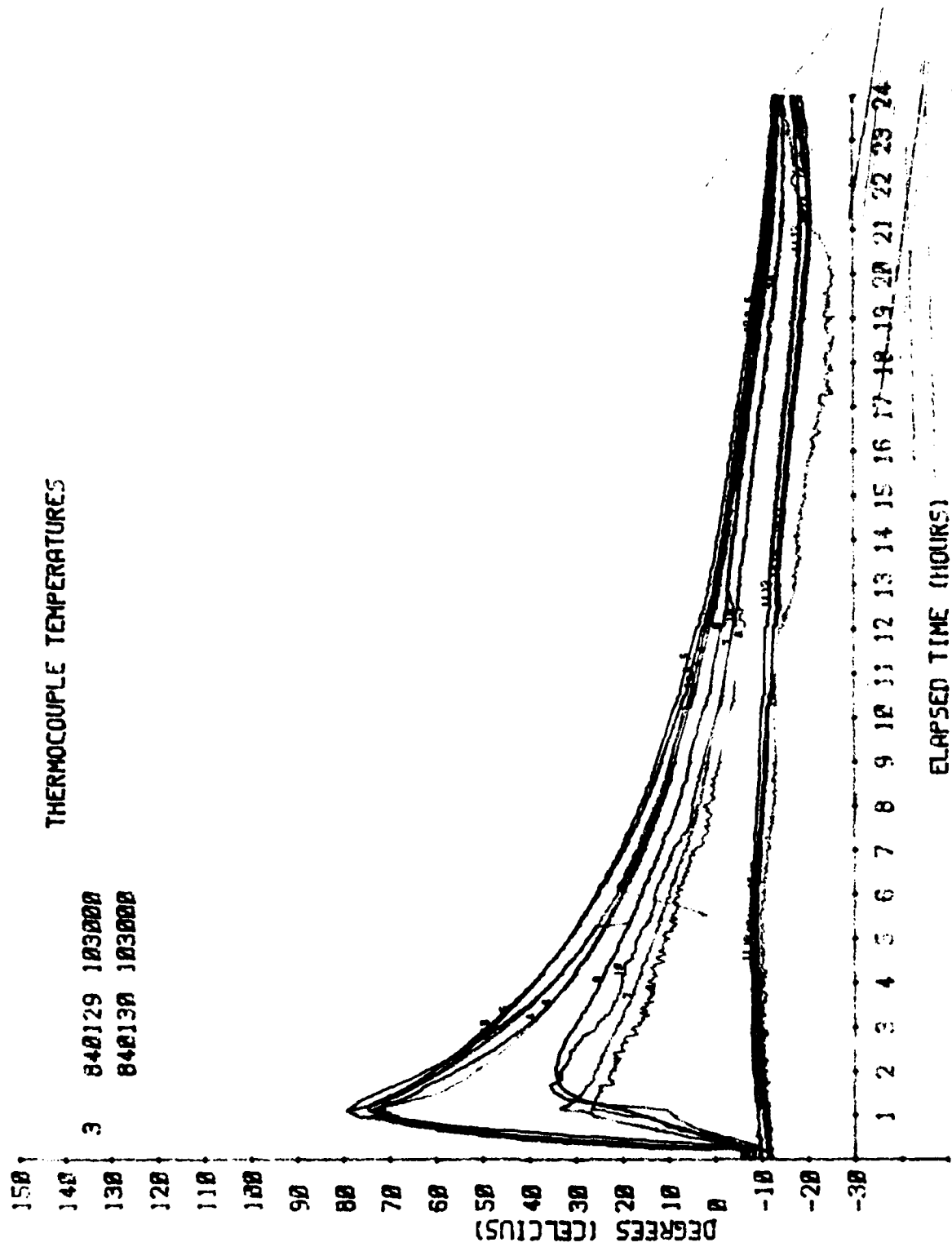


Figure C-6

UNCLASSIFIED

UNCLASSIFIED

/C-21

Table C-7

THERMOCOUPLE TEMPERATURES

			THERMOCOUPLE TEMPERATURES																	
DATE	TIME	VEH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
840130	123055	3	-12	-13	-13	-13	-12	-13	-13	-13	-12	-13	-12	-12	-13	-13	***	-13	-14	-12
840130	125655	3	-12	-13	-12	-13	-12	-13	-10	-11	-13	-13	-11	-10	-8	-9	***	-12	-13	-11
840130	125845	3	-11	-12	-12	-13	-12	-12	-4	-6	-12	-12	-11	-9	-5	-7	***	-11	-13	-11
840130	125948	3	-11	-12	-12	-13	-11	-11	-3	-4	-12	-11	-10	-5	-4	-4	***	-4	38	-11
840130	130048	3	-10	-11	-11	-12	-11	-10	-2	-2	-12	-11	-9	0	-2	-5	***	9	***	-11
840130	130148	3	-9	-7	-11	-12	-11	-8	0	0	-11	-10	-7	8	3	-4	***	23	***	-11
840130	130248	3	-8	-4	-11	-12	-11	-7	1	1	-11	-9	-4	16	9	-1	***	37	***	-11
840130	130347	3	-7	-1	-11	-11	-11	-6	3	3	-10	-8	-1	25	14	2	***	50	***	-11
840130	130510	3	-6	2	-10	-11	-10	-4	5	4	-7	-7	5	35	20	5	***	64	***	-11
840130	130610	3	-5	4	-10	-10	-10	-4	5	7	-5	-6	9	40	24	7	***	71	***	-11
840130	130744	3	-3	7	-9	-9	-9	-2	7	7	-2	-4	15	45	27	7	***	80	***	-11
840130	130846	3	-3	11	-9	-8	-9	-3	7	6	-4	-7	19	47	29	4	***	85	***	-11
840130	130946	3	-3	17	-8	-7	-9	-3	7	7	-4	-7	22	49	30	5	***	87	***	-11
840130	131146	3	-2	13	-8	-8	-9	-1	8	9	1	-4	26	55	33	12	***	90	***	-11
840130	131246	3	-2	11	-7	-8	-8	0	9	10	4	-2	29	57	36	16	***	93	***	-11
840130	131540	3	0	17	-6	-7	-7	3	11	10	9	-0	35	62	39	19	***	97	***	-11
840130	131909	3	3	20	-5	-6	-6	5	13	12	12	2	40	64	42	22	***	97	***	-11
840130	132109	3	4	23	-4	-5	-6	2	13	13	11	1	42	60	38	14	***	95	***	-11
840130	132209	3	2	25	-4	-5	-6	1	13	13	6	-1	42	58	37	12	***	94	***	-11
840130	132409	3	1	22	-4	-5	-5	4	13	15	12	2	42	63	40	20	***	98	***	-11
840130	132743	3	7	26	-3	-4	-4	6	15	17	17	4	45	68	45	24	***	***	***	-11
840130	133231	3	10	31	-1	-3	-3	9	16	18	19	6	48	69	46	26	***	***	***	-11
840130	133542	3	12	35	-1	-3	-2	10	17	19	20	7	49	68	46	28	***	98	***	-11
840130	133713	3	12	35	-0	-2	-2	11	15	18	21	8	49	53	32	23	***	***	***	-11
840130	133913	3	13	37	0	-2	-2	11	13	14	19	8	45	42	22	16	***	***	***	-11
840130	133913	3	12	20	-0	0	-1	0	11	12	10	5	42	36	15	8	***	***	***	-11
840130	134013	3	16	19	5	5	-1	5	13	8	10	1	38	33	11	5	***	***	***	-11
840130	134113	3	19	19	10	10	0	10	12	5	8	-3	35	30	8	3	***	***	***	-11
840130	134313	3	21	17	12	11	3	12	7	5	8	-4	28	26	6	3	***	***	***	-11
840130	134413	3	26	22	16	14	5	15	10	4	7	-5	25	24	5	1	***	***	***	-11
840130	134513	3	32	31	20	19	9	20	11	4	6	-7	23	23	3	-1	***	***	***	-11
840130	134613	3	36	36	24	23	15	24	6	4	6	-7	22	22	3	-1	***	***	***	-11
840130	134813	3	40	33	30	28	17	29	9	5	6	-5	19	18	2	-1	***	***	***	-11
840130	135013	3	43	38	34	32	21	33	8	5	6	-4	16	16	1	-2	***	***	***	-11
840130	135113	3	45	42	35	34	23	35	11	5	7	-4	14	15	1	-3	***	***	***	-11
840130	135313	3	47	44	39	37	27	38	12	6	7	-3	13	13	-1	-3	***	98	***	-10
840130	135413	3	49	46	40	39	30	40	15	6	7	-3	12	12	-1	-3	***	94	94	-11
840130	135513	3	50	49	42	40	34	41	13	7	8	-3	12	12	-1	-3	***	89	89	-11
840130	135613	3	51	50	43	42	36	42	13	7	8	-2	11	11	-1	-3	93	85	83	-10
840130	135713	3	52	50	44	43	39	44	13	6	9	-2	10	10	-1	-3	75	82	78	-10
840130	135813	3	53	51	46	44	41	45	14	8	9	-1	10	9	-2	-4	85	78	74	-10
840130	135913	3	53	52	47	45	42	46	13	7	9	-1	9	8	-4	-5	74	75	69	-10
840130	140013	3	55	54	48	47	44	47	15	9	10	-1	9	8	-4	-5	75	71	65	-11
840130	140213	3	57	56	50	49	46	49	17	10	11	0	7	7	-4	-6	66	65	57	-11
840130	140413	3	58	58	52	51	48	51	20	12	11	1	7	6	-4	-6	62	60	51	-10
840130	140613	3	62	60	53	52	51	53	18	10	11	-1	6	5	-5	-6	55	56	45	-10
840130	140843	3	64	63	56	55	54	55	23	12	12	-0	5	4	-6	-6	45	51	38	-10
840130	141043	3	68	65	59	58	57	59	25	13	13	-0	5	4	-5	-6	37	46	34	-9
840130	141255	3	71	69	63	62	60	62	24	15	14	1	4	3	-5	-6	29	42	30	-10
840130	141455	3	73	70	65	64	63	65	24	17	15	2	4	2	-6	-7	23	39	27	-10
840130	141655	3	75	74	68	66	64	67	25	20	16	2	3	2	-6	-7	17	36	23	-9
840130	141942	3	75	75	69	67	64	68	32	27	18	5	3	2	-5	-6	11	32	18	-8
840130	142142	3	73	75	68	67	64	67	32	26	21	10	3	1	-5	-6	10	30	17	-9
840130	142359	3	71	74	68	67	65	66	32	28	23	15	2	1	-5	-7	8	28	13	-8
840130	142559	3	70	74	68	67	66	64	31	29	24	19	2	1	-4	-5	7	26	12	-8
840130	142859	3	68	74	67	66	66	62	29	29	27	24	2	1	-2	-4	6	23	10	-9
840130	143259	3	67	73	66	65	66	59	30	29	29	29	2	1	-2	-3	5	21	8	-9
840130	143759	3	66	71	64	63	64	57	30	29	31	33	2	1	-2	-3	3	17	6	-9
840130	144800	3	63	68	61	60	61	54	29	28	34	36	2	1	-2	-3	0	13	4	-9

UNCLASSIFIED

UNCLASSIFIED

/C-22

Table C-7 (Cont'd)

THERMOCOUPLE TEMPERATURES

840130	145934	3	60	64	59	56	59	51	28	28	35	38	1	1	-2	-3	-1	8	1	-10
840130	154019	3	50	53	52	45	51	41	25	24	36	34	-0	-0	-3	-3	-2	1	-2	-8
840130	155540	3	47	49	49	41	48	39	23	22	35	32	-1	-1	-4	-4	0	-1	-4	-8
840130	161419	3	43	45	45	37	45	37	21	22	31	30	-1	-1	-4	-5	***	-3	-4	-9
840130	163621	3	39	41	42	34	42	33	20	20	31	28	-1	-1	-4	-4	***	-4	-5	-9
840130	165654	3	36	37	39	31	39	32	15	16	28	26	-2	-2	-4	-5	***	-5	-5	-8
840130	170254	3	35	36	38	28	38	32	9	15	26	24	-2	-2	-5	-5	***	-5	-5	-9
840130	170454	3	34	36	37	28	38	32	5	15	25	24	-2	-2	-5	-5	***	-5	-5	-8
840130	170554	3	34	35	37	28	38	32	12	16	25	24	-2	-2	-5	-5	***	-5	-5	-8
840130	172925	3	31	32	34	26	34	27	14	16	24	23	-2	-3	-5	-5	***	-6	-6	-9
840130	180125	3	27	28	30	23	31	25	13	14	21	20	-3	-4	-6	-6	***	-6	-6	-9
840130	184037	3	23	23	26	20	27	22	10	13	18	18	-4	-4	-6	-6	***	-7	-6	-9
840130	184137	3	23	24	26	20	27	22	0	10	18	18	-4	-4	-6	-6	***	-6	-7	-9
840130	184337	3	23	24	25	19	27	22	-4	9	18	17	-3	-4	-5	-6	***	-6	-6	-9
840130	184637	3	23	23	23	19	26	20	4	9	16	16	-4	-4	-6	-6	***	-7	-7	-9
840130	185037	3	22	22	24	19	26	20	8	11	15	16	-4	-4	-6	-6	***	-7	-7	-9
840130	193916	3	18	18	20	16	22	18	8	10	14	14	***	-7	-7	-6	***	-7	-7	-8
840130	203154	3	15	15	16	13	18	14	6	8	12	12	***	-7	-6	-6	***	-7	-7	-9
840130	213748	3	12	11	13	10	15	11	4	6	9	9	***	-8	-7	-8	77	-8	-8	-10
840130	222921	3	9	9	10	8	12	9	2	4	7	7	8	-4	-8	-8	***	-9	-9	-11
840130	235821	3	6	6	6	5	8	5	-0	1	4	4	4	-5	-9	-9	***	-9	-9	-13
840131	020521	3	3	2	2	1	4	2	-2	-1	1	1	0	-6	-9	-9	***	-9	-9	-9
840131	050321	3	-1	-1	-1	-1	-0	-2	-4	-4	-2	-2	-3	-7	-10	-10	***	-10	-10	-15
840131	090129	3	-5	-4	-5	-5	-4	-5	-8	-7	-6	-6	-7	-11	-13	-12	***	-13	-13	-14
840131	104137	3	-6	-6	-6	-6	-5	-7	-8	-8	-7	-7	-8	-9	-10	-8	***	-11	-12	-9
840131	114637	3	-6	-6	-6	-6	-6	-6	-6	-7	-6	-6	-7	-7	-6	-4	***	-8	-8	-6

UNCLASSIFIED

UNCLASSIFIED

/C-23

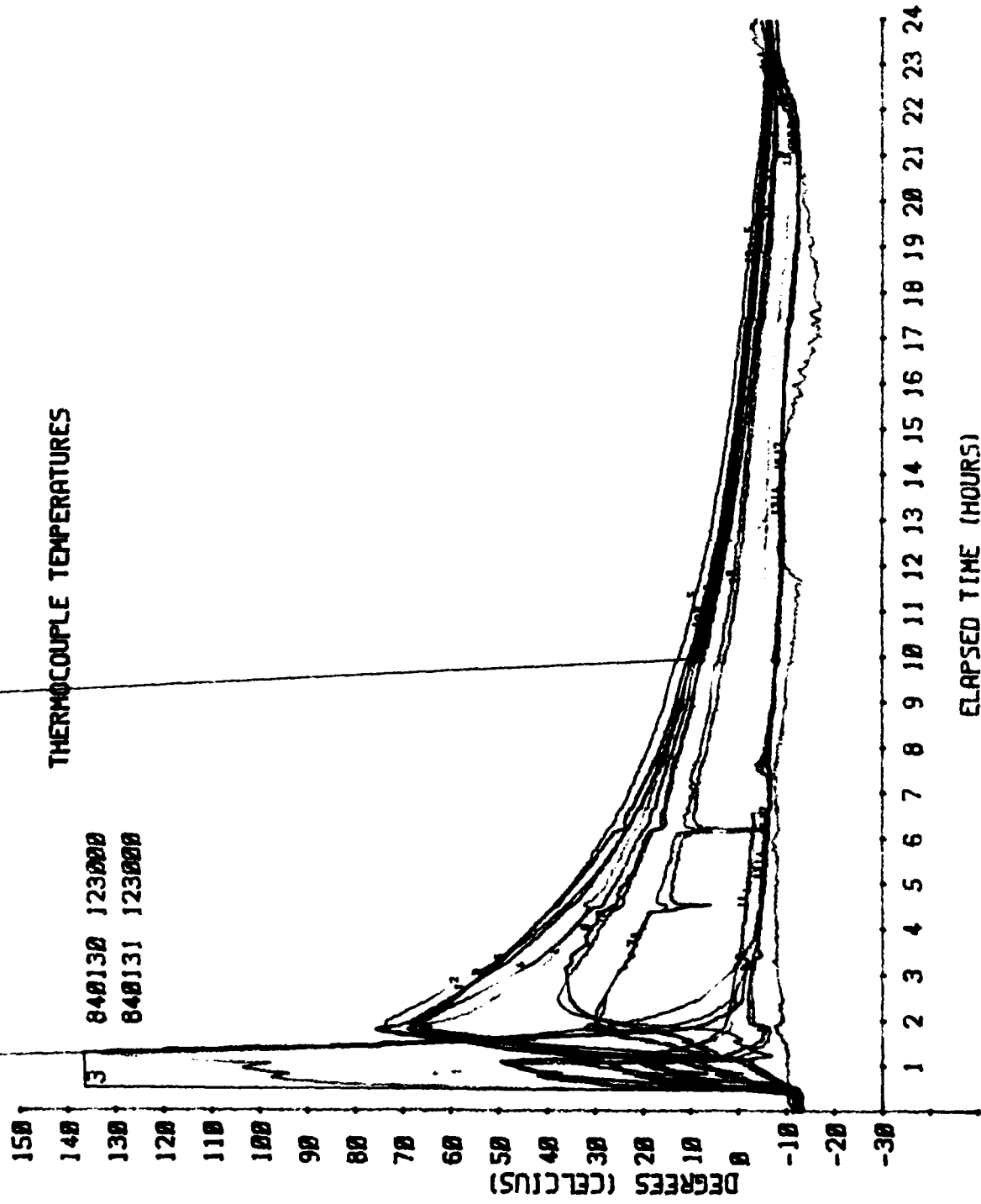


Figure C-7

UNCLASSIFIED

UNCLASSIFIED

/C-24

Table C-8

THERMOCOUPLE TEMPERATURES

THERMOCOUPLE TEMPERATURES																				
DATE	TIME	VEH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
840131	080021	3	-4	-4	-4	-4	-3	-4	-7	-6	-5	-5	-6	-10	-12	-12	***	-12	-13	-15
840131	104137	3	-6	-6	-6	-6	-5	-7	-8	-8	-7	-7	-8	-9	-10	-8	***	-11	-12	-9
840131	114637	3	-6	-6	-6	-6	-6	-6	-6	-7	-6	-6	-7	-7	-6	-4	***	-8	-8	-6
840131	132031	3	-6	-7	-5	-6	-6	-6	-3	-4	-5	-5	-5	-5	-0	-2	***	-6	-6	-2
840131	132131	3	-6	-7	-5	-6	-6	-6	4	-0	-5	-5	-5	-5	-0	-2	***	-5	-6	-2
840131	132431	3	-4	-6	-4	-5	-5	-4	8	5	-4	-4	-5	-2	3	1	***	3	***	-3
840131	132531	3	-3	-6	-4	-5	-5	-3	11	6	-3	-3	-4	4	4	3	***	15	***	-3
840131	132631	3	-2	-5	-3	-5	-5	-2	12	8	-3	-2	-3	11	7	5	***	29	***	-3
840131	132731	3	-0	-3	-3	-4	-4	-1	14	9	-1	-2	-1	18	11	8	***	44	***	-3
840131	132831	3	0	-1	-2	-4	-4	-1	15	11	0	-1	1	24	15	11	***	57	***	-3
840131	132931	3	2	1	-2	-4	-4	-0	16	12	2	0	3	29	19	13	***	67	***	-3
840131	133031	3	2	3	-1	-3	-4	1	16	13	4	1	5	34	22	15	***	75	***	-3
840131	133131	3	3	6	-1	-3	-4	2	17	14	7	2	7	38	25	17	***	79	***	-3
840131	133331	3	5	11	0	-2	-3	4	18	15	10	4	11	44	29	20	***	87	***	-3
840131	133631	3	6	17	1	-1	-3	6	18	16	15	6	14	24	24	19	***	***	***	-3
840131	133731	3	7	19	2	-1	-2	6	18	17	15	6	13	17	20	16	***	***	***	-1
840131	133931	3	8	21	2	-0	-2	7	19	17	15	7	12	12	18	15	***	***	***	-2
840131	134231	3	10	25	3	0	-1	8	20	18	15	8	10	10	16	14	***	***	***	-1
840131	134631	3	13	32	5	1	-0	10	22	19	14	9	9	8	15	14	***	***	***	-2
840131	135031	3	15	36	6	2	1	11	22	19	14	11	7	7	14	13	***	***	***	-2
840131	135331	3	16	39	6	3	1	11	23	20	13	11	7	6	13	13	***	***	99	-2
840131	135431	3	17	40	7	3	1	11	23	20	13	11	6	6	13	13	***	***	94	-2
840131	135731	3	18	43	7	3	2	12	24	21	14	12	6	5	13	12	***	88	81	-2
840131	135931	3	19	45	8	3	2	12	24	22	14	13	5	5	13	12	***	82	74	-2
840131	140131	3	20	48	9	3	3	13	25	22	14	13	5	4	13	12	***	76	67	-2
840131	144234	3	39	81	21	13	14	20	39	36	34	26	29	69	49	34	***	***	***	-1
840131	144534	3	40	84	21	13	15	21	39	35	34	26	29	47	39	31	***	***	***	-2
840131	144634	3	40	84	21	14	15	21	39	35	34	26	29	37	33	28	***	***	***	-2
840131	144834	3	40	85	22	14	16	21	39	35	34	26	28	32	30	26	***	***	***	-2
840131	145234	3	43	87	22	15	17	22	40	35	32	27	26	27	27	25	***	***	***	-3
840131	145834	3	46	91	24	17	19	23	42	35	31	28	22	22	24	23	***	***	***	-3
840131	150534	3	48	95	26	19	21	23	44	37	31	28	20	18	24	22	***	***	98	-3
840131	150634	3	48	95	26	19	21	23	45	38	31	29	19	18	24	22	***	***	93	-2
840131	150834	3	49	96	26	19	22	23	44	38	31	29	19	17	23	21	***	93	85	-2
840131	151034	3	49	97	27	20	22	24	44	38	32	29	18	17	23	21	***	87	78	-2
840131	151234	3	49	97	27	20	22	24	45	38	32	30	18	16	23	20	***	81	72	-3
840131	151434	3	50	99	28	21	23	25	45	39	32	30	17	16	22	20	***	77	67	-3
840131	151634	3	51	99	28	21	23	26	45	39	32	31	17	15	22	20	***	72	61	-3
840131	151834	3	51	***	28	22	24	26	45	38	32	31	16	15	22	20	***	69	57	-3
840131	152134	3	53	***	29	22	25	26	46	38	32	31	16	14	22	20	***	64	51	-3
840131	152434	3	53	***	29	23	25	26	46	38	32	31	15	13	22	20	***	59	46	-3
840131	152734	3	54	***	30	23	26	27	47	38	32	31	15	13	22	20	***	55	42	-3
840131	153134	3	56	***	31	24	27	27	47	39	33	32	15	13	22	19	***	50	37	-4
840131	153634	3	57	***	31	25	28	28	47	38	33	32	14	12	21	19	***	45	33	-4
840131	154134	3	58	***	32	27	29	29	48	40	34	33	14	11	21	19	***	41	29	-4
840131	154634	3	59	***	33	28	30	30	49	39	34	34	13	11	21	19	***	37	25	-4
840131	155434	3	61	***	34	30	32	32	51	42	35	35	13	11	21	19	***	32	22	-3
840131	160934	3	64	***	37	33	34	32	53	44	38	38	13	9	20	18	***	28	18	-4
840131	161634	3	65	***	38	34	36	32	53	45	38	38	12	9	20	18	***	24	17	-4
840131	163016	3	68	***	41	37	38	35	54	46	40	41	12	9	20	17	***	19	15	-4
840131	163316	3	68	***	41	37	39	35	42	41	40	41	12	9	17	16	***	19	15	-4
840131	163516	3	68	***	41	37	39	35	38	38	40	40	11	8	16	15	***	20	15	-4
840131	164216	3	67	***	40	37	39	35	34	34	38	38	11	8	14	13	***	18	14	-3
840131	164916	3	66	***	39	37	39	34	31	32	36	36	10	7	12	11	93	17	13	-4
840131	165116	3	66	***	39	37	39	34	31	32	36	36	10	8	12	11	87	16	13	-4
840131	165316	3	66	***	39	37	39	34	30	31	35	35	10	7	11	10	81	16	12	-3
840131	165516	3	66	***	39	37	39	34	29	31	35	35	10	7	11	10	74	15	12	-3
840131	165716	3	65	***	38	37	39	33	29	30	35	35	10	7	10	9	67	14	12	-4
840131	165816	3	65	***	38	37	39	33	28	29	34	34	10	7	10	10	59	14	12	-4

UNCLASSIFIED

UNCLASSIFIED

/C-25

Table C-8 (Cont'd)

THERMOCOUPLE TEMPERATURES

840131	170316	3	64	96	38	37	39	33	27	29	33	33	10	7	9	8	54	13	11	-	4						
840131	170416	3	64	96	38	37	39	33	27	28	34	33	9	7	9	8	47	13	11	-	3						
840131	171016	3	63	92	37	37	39	32	26	28	32	32	9	6	8	7	42	12	10	-	3						
840131	171516	3	62	89	37	36	39	32	25	27	32	32	9	6	7	7	37	11	9	-	4						
840131	172016	3	61	87	36	36	38	32	25	26	31	31	8	5	6	6	31	10	9	-	3						
840131	172716	3	59	83	36	35	38	31	24	26	30	30	8	5	6	6	27	9	8	-	3						
840131	173816	3	54	78	35	34	38	31	22	25	29	29	8	4	5	5	21	8	7	-	3						
840131	174745	3	52	74	35	33	37	31	22	24	28	29	7	4	4	4	18	7	6	-	3						
840131	180614	3	47	66	35	32	36	29	20	22	27	27	7	3	-	0	-	0	***	4	3	-	4				
840131	181812	3	45	62	34	31	35	29	20	22	26	26	7	2	-	1	-	1	***	3	2	-	4				
840131	183203	3	42	57	33	29	34	28	19	20	25	25	6	2	-	1	-	1	***	1	-	0	-	5			
840131	184603	3	40	53	32	28	33	27	18	19	24	24	6	1	-	2	-	2	***	0	-	1	-	4			
840131	190225	3	37	49	31	27	32	26	17	18	23	23	6	1	-	2	-	2	***	-	0	-	1	-	5		
840131	192035	3	35	45	30	26	31	25	16	17	22	22	5	1	-	2	-	2	***	-	1	-	2	-	5		
840131	193935	3	33	41	29	24	29	24	15	16	21	21	5	0	-	2	-	2	***	-	2	-	3	-	5		
840131	200222	3	30	37	27	23	28	23	13	13	20	18	4	0	-	1	-	1	***	-	2	-	3	-	1		
840131	203022	3	27	33	25	21	26	21	13	12	18	16	4	-	0	-	1	-	1	***	-	1	-	2	-	1	
840131	210222	3	25	29	23	20	24	19	12	11	16	14	3	0	-	1	-	0	***	-	1	-	1	-	1		
840131	214422	3	22	25	21	18	22	18	10	10	15	13	3	0	-	1	-	1	***	-	1	-	1	-	1		
840131	223522	3	19	20	18	15	19	15	9	8	13	11	2	0	-	1	-	1	***	-	1	-	1	-	1		
840131	233934	3	15	16	15	13	16	13	8	8	11	10	2	-	0	-	2	-	1	***	-	2	-	2	-	2	
840201	011034	3	12	12	12	10	13	10	6	7	9	9	1	-	1	-	2	-	3	***	-	2	-	2	-	5	
840201	032134	3	8	8	8	7	9	7	3	4	6	6	-	0	-	3	-	4	-	4	***	-	4	-	4	-	6
840201	055734	3	5	5	4	4	5	4	0	1	3	3	-	2	-	4	-	6	-	6	***	-	6	-	6	-	7

UNCLASSIFIED

UNCLASSIFIED

/C-26

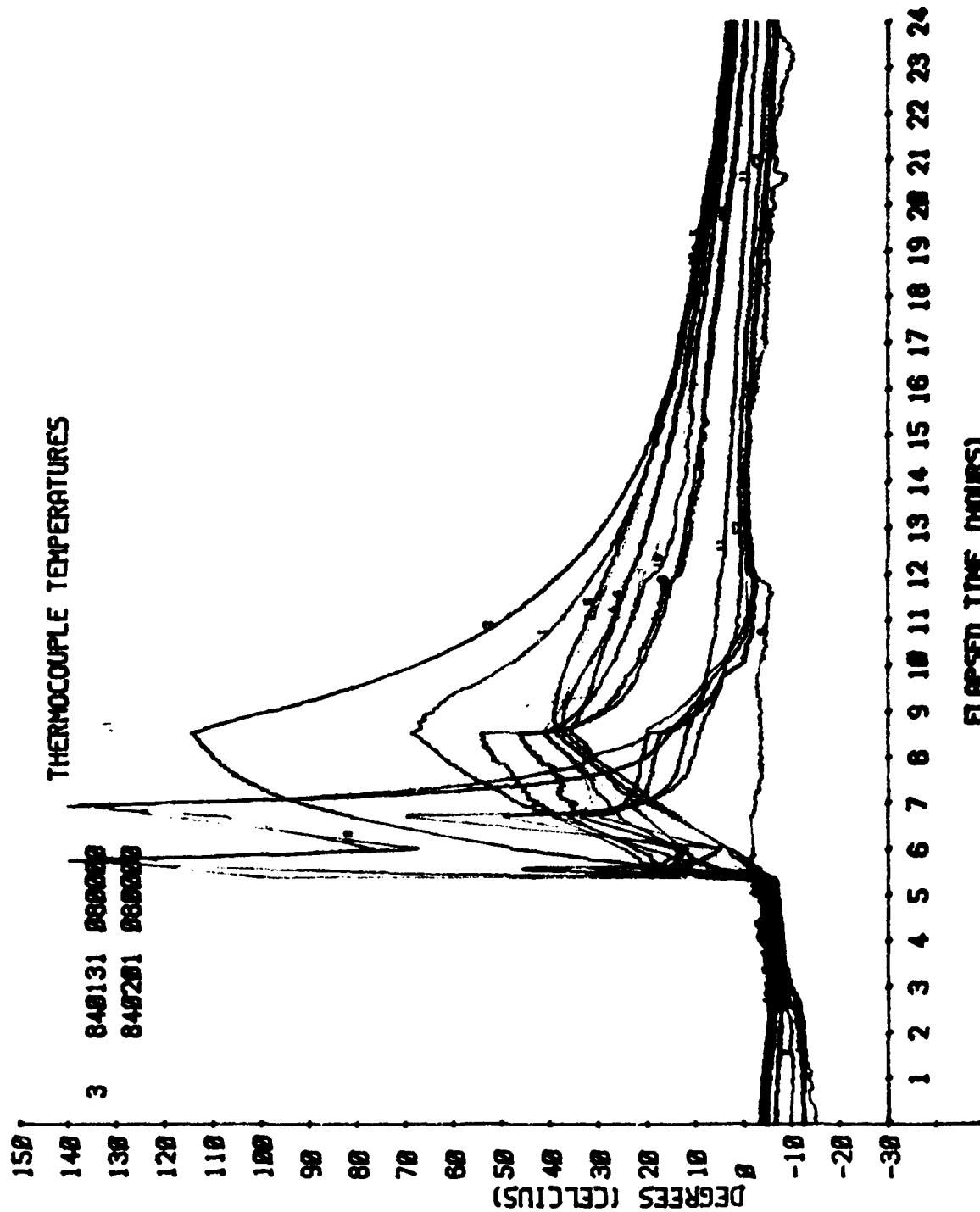


Figure C-8

UNCLASSIFIED

UNCLASSIFIED

/C-27

Table C-9

THERMOCOUPLE TEMPERATURES

			THERMOCOUPLE TEMPERATURES																	
DATE	TIME	VEH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
840201	083218	3	2	2	2	1	3	1	-	1	-	1	1	1	-	3	-	5	-	6
840201	084259	3	2	2	2	1	2	1	1	1	1	0	-	3	-	5	2	-	0	***
840201	084659	3	4	2	2	2	3	4	10	12	1	2	-	0	13	9	4	***	38	***
840201	084759	3	5	3	2	2	3	5	11	14	2	3	1	19	14	7	***	53	***	-
840201	085559	3	10	16	5	5	5	12	16	20	16	9	12	38	24	12	***	90	***	-
840201	090259	3	13	25	7	7	6	15	20	26	23	13	15	40	32	26	***	***	***	-
840201	090759	3	15	31	8	8	7	18	22	28	25	15	17	43	35	28	***	***	***	-
840201	090959	3	16	34	8	8	7	19	20	28	26	15	17	29	32	26	***	***	***	-
840201	091059	3	16	35	8	9	7	19	20	27	25	15	17	23	27	22	***	***	***	-
840201	091259	3	17	35	8	8	7	19	14	19	24	15	16	19	21	18	***	***	***	-
840201	091559	3	17	35	9	9	7	17	11	14	22	13	15	15	18	15	***	***	***	-
840201	092059	3	17	35	8	7	8	14	9	12	19	11	14	12	14	12	***	***	***	-
840201	092359	3	17	34	8	7	8	14	9	11	17	11	13	11	13	11	96	***	***	-
840201	092559	3	18	34	8	7	8	14	9	11	16	10	12	10	11	10	91	***	***	-
840201	092759	3	17	33	8	7	8	13	8	10	15	10	12	8	8	7	84	***	99	-
840201	092859	3	17	34	8	7	8	13	9	10	15	10	12	8	8	7	78	97	94	-
840201	092959	3	17	33	8	7	8	12	8	10	14	10	11	8	7	6	74	93	89	-
840201	093059	3	17	33	8	7	8	12	8	10	14	10	11	7	7	6	71	89	84	-
840201	093159	3	17	33	8	7	8	12	8	9	14	9	10	7	6	5	69	86	79	-
840201	093259	3	17	33	8	7	8	12	8	10	14	9	11	7	5	5	65	82	75	-
840201	093359	3	16	33	7	6	8	12	8	9	13	9	10	6	5	4	61	79	71	-
840201	093559	3	16	32	7	6	8	11	8	9	13	9	9	11	8	5	54	26	***	-
840201	093759	3	16	32	7	6	8	11	8	9	12	8	9	16	10	7	49	35	***	-
840201	093859	3	16	32	7	6	8	11	8	9	13	8	9	22	12	8	46	49	***	-
840201	093959	3	16	32	7	6	8	11	8	9	14	8	10	29	14	8	45	61	***	-
840201	094059	3	16	31	7	6	8	11	8	9	14	8	10	33	15	9	46	69	***	-
840201	094159	3	16	32	7	6	8	11	8	9	15	9	11	36	18	11	***	78	***	-
840201	094259	3	16	31	7	6	8	10	8	9	16	8	12	38	19	12	***	83	***	-
840201	094359	3	16	31	7	6	8	10	8	9	17	8	12	41	21	13	***	89	***	-
840201	094459	3	16	31	7	6	8	10	10	11	17	8	13	43	23	14	***	95	***	-
840201	094559	3	16	31	7	6	8	10	15	16	18	8	14	47	28	19	***	***	***	-
840201	094659	3	16	31	8	7	8	11	17	19	19	9	14	51	33	24	***	***	***	-
840201	094859	3	16	34	8	7	8	12	20	23	21	11	16	56	37	28	***	***	***	-
840201	095159	3	18	34	9	8	9	15	23	27	24	13	19	57	40	31	***	***	***	-
840201	095259	3	19	35	10	8	9	16	22	27	25	14	19	39	34	28	***	***	***	-
840201	095525	3	20	37	10	8	10	18	22	27	24	15	19	26	28	23	***	***	***	-
840201	095917	3	22	43	11	8	11	20	23	28	22	16	18	21	26	21	***	***	***	-
840201	100525	3	24	47	12	9	12	23	25	30	21	18	17	17	23	19	***	***	***	-
840201	101025	3	27	52	13	9	13	24	26	31	21	19	16	14	22	17	***	***	***	-
840201	101325	3	28	54	14	10	14	25	27	31	21	19	15	13	21	17	***	***	96	-
840201	101425	3	29	56	14	10	14	25	27	32	21	19	15	13	21	17	***	96	92	-
840201	101625	3	29	56	14	10	14	25	23	27	21	20	14	12	18	16	***	89	84	-
840201	101725	3	30	56	14	10	14	25	19	23	21	19	14	12	16	15	***	86	81	-
840201	101836	3	30	56	14	10	14	24	18	21	20	19	14	11	15	14	***	82	76	-
840201	101953	3	30	56	14	11	14	23	17	20	20	19	14	11	12	12	***	78	72	-
840201	102153	3	30	56	14	11	14	22	17	19	19	18	13	10	10	10	***	72	64	-
840201	103013	3	28	54	14	11	15	20	15	17	18	16	12	8	7	6	***	52	42	-
840201	103213	3	28	53	14	11	15	19	15	17	17	16	12	8	6	6	95	49	38	-
840201	103513	3	28	53	14	12	15	19	14	16	17	15	11	11	8	7	***	19	85	-
840201	103739	3	28	52	14	12	15	19	18	20	17	15	11	18	14	10	***	34	***	-
840201	103839	3	28	52	14	12	15	19	18	19	17	15	12	23	14	8	***	48	***	-
840201	103939	3	28	53	14	12	15	19	16	20	18	15	12	27	15	8	***	60	***	-
840201	104022	3	28	53	14	12	15	19	14	21	18	16	12	30	16	8	***	68	***	-
840201	104122	3	29	55	14	13	15	19	20	22	19	16	13	35	18	10	***	77	***	-
840201	104222	3	29	54	14	13	16	19	20	22	20	16	14	38	19	12	***	83	***	-
840201	104343	3	30	56	15	13	16	19	22	23	22	16	15	42	22	12	***	89	***	-
840201	104544	3	31	57	15	14	16	20	19	24	24	17	16	46	25	13	***	96	***	-
840201	104952	3	33	61	16	14	17	20	22	25	27	18	19	51	27	18	***	***	***	-
840201	105456	3	35	66	17	15	18	21	19	27	29	19	22	54	29	18	***	***	***	-

UNCLASSIFIED

UNCLASSIFIED

/C-28

Table C-9 (Cont'd)

THERMOCOUPLE TEMPERATURES

840201	105958	3	38	70	18	16	19	21	14	28	30	20	25	56	30	21	***	***	***	-	1	
840201	110055	3	38	71	18	16	19	21	9	28	31	20	25	56	32	23	***	***	***	-	2	
840201	110155	3	38	72	18	16	19	22	5	26	31	20	26	56	33	24	***	***	***	-	1	
840201	110455	3	40	74	18	16	20	23	11	27	31	19	27	57	32	24	***	***	***	-	1	
840201	110655	3	41	75	19	16	20	25	7	25	31	19	27	57	33	25	***	***	***	-	2	
840201	111155	3	43	79	19	17	21	28	14	27	30	18	28	57	32	25	***	***	***	-	1	
840201	111255	3	44	79	19	17	21	28	8	26	31	18	29	57	33	24	***	***	***	-	1	
840201	111355	3	45	80	19	18	22	29	13	28	30	18	29	57	34	26	***	***	***	-	1	
840201	111455	3	45	81	19	18	22	29	7	26	31	18	29	57	34	25	***	***	***	-	2	
840201	111655	3	46	82	20	18	22	29	15	30	31	18	30	58	34	25	***	***	***	-	1	
840201	111755	3	46	83	20	18	23	29	20	31	31	19	30	59	33	23	***	***	***	-	1	
840201	112555	3	47	88	22	20	24	27	17	32	34	23	32	59	35	26	***	***	***	-	1	
840201	112655	3	47	88	22	20	24	27	23	32	34	23	32	59	35	26	***	***	***	-	1	
840201	113055	3	48	90	22	21	25	26	9	30	35	24	33	60	36	27	***	***	***	-	1	
840201	113255	3	50	91	22	21	25	26	2	26	35	24	33	60	36	28	***	***	***	-	1	
840201	113455	3	50	92	22	21	26	28	7	30	35	23	33	60	35	27	***	***	***	-	1	
840201	113555	3	50	93	23	21	26	28	17	32	35	23	33	60	36	27	***	***	***	-	1	
840201	113655	3	50	93	23	21	26	29	13	33	35	23	34	60	36	28	***	***	***	-	1	
840201	113755	3	50	93	23	22	26	29	17	34	35	23	34	60	36	27	***	***	***	-	1	
840201	114155	3	52	95	24	22	27	30	9	32	36	24	35	60	35	26	***	***	***	-	1	
840201	114555	3	53	96	24	23	28	31	5	29	36	24	35	61	36	27	***	***	***	-	1	
840201	114955	3	53	98	24	23	28	33	9	31	35	23	36	60	35	25	***	***	***	-	1	
840201	115155	3	54	99	25	23	29	33	5	31	35	23	36	60	36	26	***	***	***	-	1	
840201	115355	3	54	98	25	24	29	33	2	24	35	22	36	50	31	25	***	***	***	-	1	
840201	115455	3	54	98	25	24	29	33	3	24	34	22	36	43	30	24	***	***	***	-	1	
840201	115555	3	54	97	25	24	29	32	16	28	34	22	36	39	31	25	***	***	***	-	1	
840201	115655	3	54	97	26	24	29	31	21	29	33	22	35	37	31	26	***	***	***	-	1	
840201	120055	3	52	95	26	24	29	31	23	29	32	23	35	33	30	25	***	***	***	-	1	
840201	120555	3	52	93	26	24	29	31	22	28	30	24	33	29	25	23	***	***	***	-	1	
840201	121155	3	52	89	26	25	28	30	22	28	29	25	32	26	22	20	98	***	***	-	1	
840201	121355	3	51	88	26	25	28	30	22	27	28	25	31	24	21	19	90	***	***	-	1	
840201	121455	3	51	88	27	25	28	30	22	27	28	25	31	24	21	18	86	***	99	-	1	
840201	121555	3	51	87	26	25	28	30	22	27	28	25	31	24	20	18	83	***	95	-	1	
840201	121655	3	51	86	26	25	28	30	22	27	27	25	30	23	20	18	81	97	91	-	1	
840201	121855	3	50	85	26	25	28	29	22	27	27	25	30	23	19	17	75	90	83	-	1	
840201	122055	3	50	84	26	25	28	29	22	26	27	25	30	22	19	16	70	84	77	-	1	
840201	122255	3	49	83	27	25	28	29	22	26	26	26	29	21	18	16	66	79	71	-	1	
840201	122455	3	49	82	26	25	28	29	22	26	26	25	29	21	17	15	61	74	66	-	1	
840201	122655	3	49	81	27	25	28	28	22	25	26	25	29	20	17	15	58	70	61	-	1	
840201	122855	3	49	80	26	25	28	28	22	25	26	25	28	20	16	14	56	66	57	-	1	
840201	123155	3	49	78	26	25	28	28	21	25	25	25	28	19	16	14	52	60	51	-	1	
840201	123455	3	48	77	26	25	28	27	21	24	25	25	27	19	15	13	50	56	46	-	1	
840201	123755	3	48	75	26	25	28	27	21	24	25	25	27	18	14	12	48	52	42	-	1	
840201	124155	3	47	74	26	25	28	27	20	24	25	25	26	17	13	12	43	47	37	-	1	
840201	124555	3	47	72	26	25	28	26	20	23	24	24	26	17	13	12	38	43	33	-	1	
840201	125055	3	45	69	26	25	28	26	20	23	24	24	25	16	12	11	34	38	29	-	1	
840201	125655	3	43	67	26	25	27	25	19	22	23	24	25	15	10	9	30	33	25	-	1	
840201	125855	3	43	66	26	25	27	25	17	19	23	23	24	15	10	8	25	30	23	-	1	
840201	125955	3	43	66	26	25	27	25	2	15	23	23	24	15	10	8	21	30	22	-	2	
840201	130255	3	40	65	25	24	27	23	-	1	10	21	20	24	15	10	8	17	28	19	-	2
840201	130955	3	37	61	23	23	26	23	-	1	7	16	15	24	15	9	8	14	25	16	-	1
840201	131755	3	35	58	22	22	25	22	-	1	5	12	12	23	14	9	7	12	20	13	-	2
840201	132755	3	32	54	21	20	24	21	-	1	3	8	10	22	13	8	6	9	17	11	-	2
840201	133855	3	29	50	20	19	23	20	-	1	3	6	8	22	13	7	5	8	14	9	-	2
840201	134955	3	27	45	18	17	21	19	-	1	2	5	8	21	12	6	5	7	11	7	-	2
840201	140147	3	25	41	17	15	19	17	-	2	1	4	6	20	11	6	4	6	10	6	-	1
840201	141547	3	22	37	15	14	17	16	-	2	0	3	5	20	11	5	4	4	8	5	-	2
840201	143137	3	20	33	13	12	16	14	-	2	-	0	2	4	19	10	4	3	3	7	-	2
840201	144937	3	17	29	11	10	14	13	-	2	-	0	1	4	19	9	4	3	3	5	-	2
840201	150937	3	14	25	10	8	12	11	-	2	-	0	0	3	18	8	3	2	2	4	-	1
840201	153824	3	12	20	8	7	10	8	-	2	-	0	0	2	17	8	3	1	2	3	-	2

UNCLASSIFIED

/C-29

Table C-9 (Cont'd)
THERMOCOUPLE TEMPERATURES

840201	160824	3	9	16	5	5	8	6	-	2	-	1	-	0	1	16	7	2	0	1	2	1	-	2					
840201	165100	3	7	2	3	3	6	4	***	-	2	-	1	0	14	***	1	-	0	-	0	0	***	-	3				
840201	165152	3	7	***	3	3	6	4	2	-	2	-	1	0	14	***	1	-	0	-	0	0	***	-	3				
840201	165253	3	7	***	3	3	6	4	***	-	2	-	1	0	14	2	1	-	0	-	0	0	***	-	3				
840201	165341	3	7	***	3	3	6	4	***	-	2	-	1	0	14	***	1	-	0	-	0	0	2	-	3				
840201	171112	3	6	***	2	2	5	3	96	-	2	-	1	-	0	13	***	0	-	1	-	0	-	0	***	-	3		
840201	171243	3	6	***	2	2	5	3	***	-	2	-	1	-	0	13	***	0	-	1	-	1	-	0	97	-	3		
840201	171707	3	5	10	2	2	4	3	-	3	-	2	-	1	-	13	4	-	0	-	1	-	1	-	0	-	3		
840201	182907	3	3	6	0	1	2	1	-	2	-	2	-	1	-	11	3	-	1	-	1	***	-	1	-	1	-	2	
840201	203907	3	1	2	-	1	-	0	-	0	-	0	-	1	-	8	2	-	1	-	1	***	-	1	-	1	-	2	
840202	011619	3	0	-	0	-	1	-	0	-	0	-	1	-	1	-	4	-	0	-	2	-	2	***	-	2	-	3	
840202	074719	3	-	1	-	2	-	2	-	2	-	2	-	2	-	0	-	2	-	3	-	3	***	-	3	-	3	-	4

UNCLASSIFIED

UNCLASSIFIED

/C-30

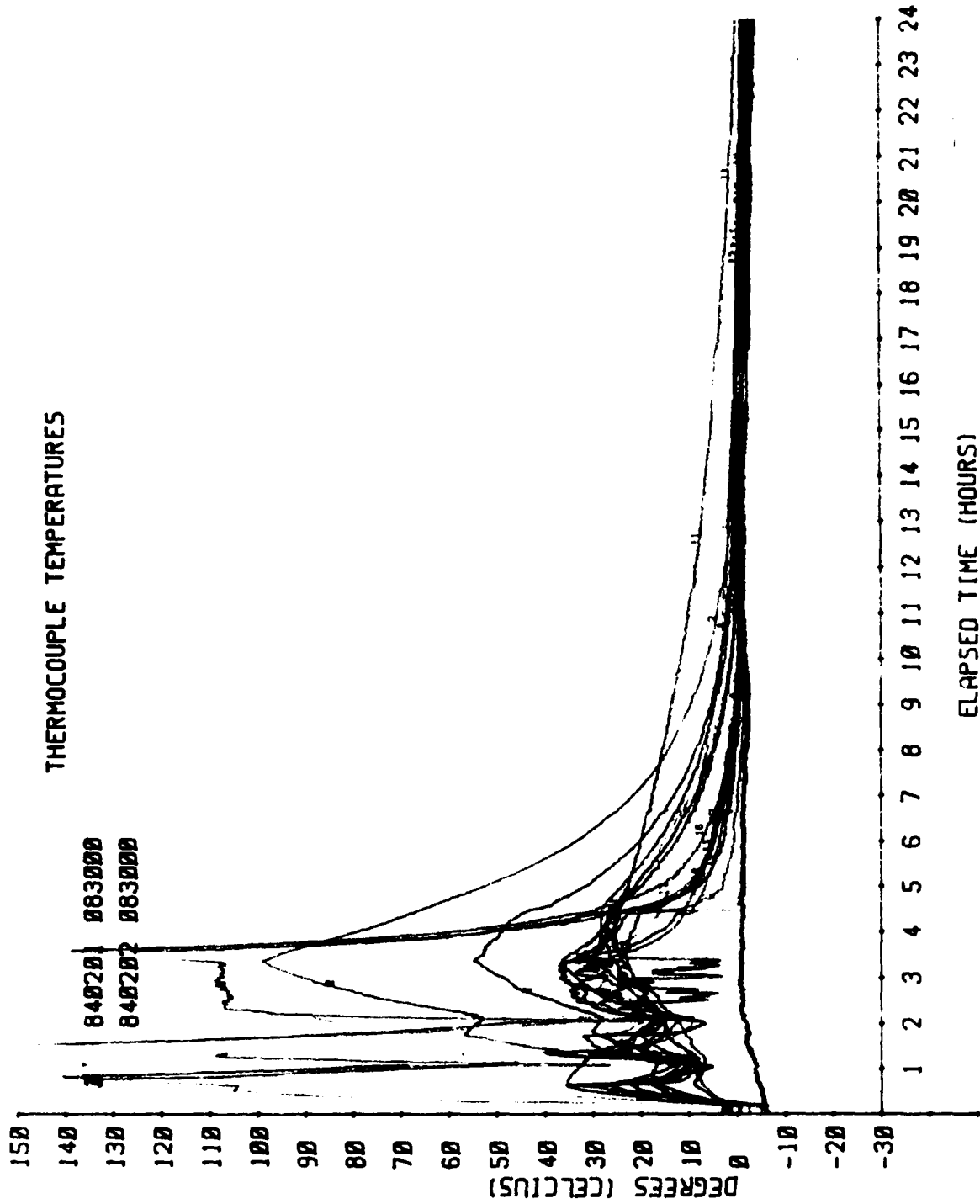


Figure C-9

UNCLASSIFIED

UNCLASSIFIED

/C-31

Table C-10

THERMOCOUPLE TEMPERATURES

			THERMOCOUPLE TEMPERATURES																	
DATE	TIME	VEH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
840202	092006	3	-	2	-	2	-	2	-	3	-	3	-	3	-	4	***	-	4	-
840202	094051	3	3	-	0	-	1	-	1	4	13	15	-	0	1	-	6	10	6	***
840202	094151	3	4	2	-	0	-	1	-	1	5	14	15	0	2	0	12	10	8	***
840202	094651	3	9	13	2	1	0	10	13	14	9	6	5	32	22	18	***	81	***	-
840202	094851	3	9	15	2	1	0	9	8	10	12	6	7	36	24	19	***	85	***	-
840202	095151	3	8	16	2	0	0	8	7	8	15	5	9	40	26	20	***	87	***	-
840202	095551	3	8	16	2	0	0	7	7	8	17	4	12	43	29	21	98	90	***	-
840202	095651	3	8	16	2	0	0	6	8	8	17	5	13	44	29	22	91	91	***	-
840202	095751	3	8	16	2	0	1	6	8	8	18	4	14	44	28	20	85	91	***	-
840202	095851	3	8	16	2	0	0	6	8	8	19	4	14	45	27	20	80	91	***	-
840202	100051	3	7	16	2	0	0	6	13	13	19	4	16	45	26	18	***	96	***	-
840202	100151	3	8	16	3	0	1	6	17	16	19	5	16	47	31	23	***	***	***	-
840202	100351	3	9	18	4	1	1	7	20	20	21	8	17	49	32	24	***	***	***	-
840202	100551	3	11	20	4	1	2	9	21	22	22	10	19	52	37	30	***	***	***	-
840202	101451	3	16	30	7	3	4	14	24	26	27	14	22	52	33	23	***	***	***	-
840202	101551	3	16	31	7	3	4	15	24	27	27	15	22	54	35	27	***	***	***	-
840202	101651	3	17	33	8	3	5	16	25	29	28	15	23	56	40	32	***	***	***	-
840202	102051	3	19	38	8	3	6	18	26	31	29	17	25	58	43	36	***	***	***	-
840202	102151	3	20	39	9	3	6	18	25	29	29	17	25	56	38	31	***	***	***	-
840202	102351	3	21	40	9	3	6	19	26	31	30	18	26	57	43	35	***	***	***	-
840202	102851	3	23	46	11	4	8	20	28	33	31	19	27	58	44	36	***	***	***	-
840202	103251	3	25	49	12	5	9	21	27	35	32	20	28	49	41	34	***	***	***	-
840202	103351	3	25	49	12	5	9	21	27	34	32	20	28	38	36	30	***	***	***	-
840202	103551	3	26	52	12	6	10	22	27	34	31	21	28	33	34	29	***	***	***	-
840202	103951	3	28	55	13	7	10	23	26	32	29	21	27	28	27	21	***	***	***	-
840202	104051	3	28	57	13	7	11	23	27	32	28	20	26	39	25	19	***	86	***	-
840202	104151	3	29	57	13	7	11	24	27	33	28	21	26	38	29	20	***	74	***	-
840202	104351	3	30	58	14	8	12	25	27	33	28	21	26	31	26	20	***	***	***	-
840202	104451	3	30	59	14	8	12	25	27	34	28	21	26	26	28	23	***	***	***	-
840202	104851	3	31	61	14	8	13	26	28	35	27	22	24	22	28	24	***	***	***	-
840202	105351	3	33	66	15	9	14	26	29	35	26	22	23	19	26	23	***	***	***	-
840202	105751	3	35	67	16	10	15	27	29	36	26	23	22	17	26	21	***	***	99	-
840202	105951	3	35	68	16	11	15	27	30	36	26	23	22	17	26	21	***	***	94	-
840202	110051	3	35	69	17	11	15	28	29	34	26	23	21	23	22	17	***	48	***	-
840202	110151	3	36	69	17	11	15	28	30	36	26	23	21	25	23	19	***	43	***	-
840202	110251	3	36	70	17	11	15	28	30	37	26	23	21	28	26	23	***	51	***	-
840202	110351	3	36	70	17	11	16	28	30	38	26	23	21	31	27	25	***	62	***	-
840202	110451	3	37	71	18	12	16	29	31	38	26	24	22	34	30	26	***	72	***	-
840202	110551	3	37	71	18	12	16	29	31	38	27	24	22	36	27	23	***	77	***	-
840202	110651	3	37	73	18	12	16	29	30	37	28	24	22	36	26	21	***	83	***	-
840202	110751	3	38	72	18	12	17	29	31	38	29	24	22	40	30	24	***	93	***	-
840202	110851	3	38	74	18	13	17	29	31	38	29	24	22	44	35	28	***	***	***	-
840202	111151	3	39	74	19	13	17	30	32	40	31	25	23	49	37	29	***	***	***	-
840202	111351	3	39	75	19	14	18	30	33	41	32	26	24	53	42	34	***	***	***	-
840202	111851	3	41	77	21	15	19	30	30	34	34	27	26	56	43	35	***	***	***	-
840202	111951	3	41	77	21	15	19	30	28	32	35	27	26	53	33	26	***	***	***	-
840202	112151	3	41	77	21	15	19	29	33	38	35	26	27	56	39	30	***	***	***	-
840202	112351	3	41	77	21	16	20	30	35	41	35	27	28	60	44	36	***	***	***	-
840202	112751	3	42	79	22	16	20	32	35	42	37	28	30	51	44	37	***	***	***	-
840202	112851	3	43	79	22	17	21	32	34	41	37	28	30	39	39	34	***	***	***	-
840202	113051	3	43	80	23	17	21	33	34	41	36	29	29	34	36	31	***	***	***	-
840202	113451	3	44	81	23	18	22	33	34	40	35	29	29	30	31	26	***	***	***	-
840202	113551	3	44	81	23	18	22	33	34	40	35	29	28	43	28	23	***	82	***	-
840202	113651	3	44	82	23	18	22	33	35	41	35	29	29	44	30	25	***	70	***	-
840202	113751	3	45	82	24	18	23	34	35	42	35	29	29	47	35	30	***	77	***	-
840202	113951	3	45	83	24	19	23	34	37	43	35	30	29	53	39	34	***	91	***	-
840202	114051	3	46	83	25	19	23	34	38	44	35	30	30	55	41	35	***	96	***	-
840202	114351	3	47	84	25	19	24	35	38	45	37	31	30	60	45	38	***	***	***	-
840202	114551	3	47	85	26	20	24	35	36	41	37	31	31	41	37	32	***	***	***	-

UNCLASSIFIED

Table C-10 (Cont'd)

THERMOCOUPLE TEMPERATURES

840202	114651	3	47	85	26	20	24	35	28	35	37	31	30	37	25	23	***	***	***	-	4
840202	114849	3	47	84	25	20	24	33	21	24	36	30	30	33	19	15	***	***	***	-	4
840202	114949	3	46	84	25	20	24	33	6	23	36	29	30	32	20	16	***	***	***	-	4
840202	115249	3	45	82	24	20	25	29	8	19	33	26	29	27	17	13	***	***	***	-	4
840202	115349	3	44	82	24	20	25	28	14	18	31	25	29	26	14	11	***	***	***	-	4
840202	115449	3	44	81	24	20	24	28	14	14	30	24	29	26	12	7	***	***	***	-	4
840202	115649	3	43	81	24	20	25	28	15	10	28	21	28	23	8	4	***	***	***	-	4
840202	115949	3	43	80	23	20	25	27	14	10	26	17	27	21	7	4	***	98	98	-	4
840202	120049	3	43	79	23	20	25	26	12	10	25	15	27	21	6	3	***	92	91	-	4
840202	120149	3	43	78	23	20	25	26	11	11	24	15	27	20	6	3	***	87	84	-	4
840202	120249	3	43	78	23	19	24	26	12	6	23	14	26	19	4	2	***	81	79	-	4
840202	120349	3	43	77	23	19	24	26	10	9	23	14	26	19	4	2	***	77	73	-	4
840202	120449	3	43	77	23	20	24	26	12	10	22	13	26	19	6	3	***	73	68	-	4
840202	120549	3	43	76	23	20	24	25	11	8	22	13	25	18	6	2	***	68	63	-	4
840202	120649	3	43	76	23	20	24	25	11	8	21	13	25	18	6	2	***	65	59	-	4
840202	120749	3	43	75	23	20	24	25	11	8	21	13	25	17	4	1	***	62	55	-	4
840202	120949	3	43	74	23	19	24	24	9	10	20	12	24	16	5	3	***	55	47	-	4
840202	121149	3	43	73	23	20	24	23	8	9	19	13	24	16	6	2	***	50	42	-	4
840202	121249	3	42	73	22	19	24	23	9	4	19	12	23	15	2	0	***	47	39	-	4
840202	121349	3	42	72	22	20	24	23	7	10	18	12	23	15	3	1	***	44	36	-	4
840202	121449	3	42	71	22	19	24	23	10	5	18	11	23	15	2	0	***	42	34	-	4
840202	121649	3	42	71	22	19	24	23	10	5	17	10	23	14	1	0	***	37	29	-	4
840202	121949	3	41	69	22	19	23	22	11	4	16	9	22	14	2	0	***	31	24	-	3
840202	122249	3	41	68	22	19	23	22	9	2	15	8	22	13	1	1	***	27	19	-	3
840202	122549	3	41	66	21	19	23	21	7	2	14	7	21	12	0	2	***	22	15	-	4
840202	122649	3	40	66	21	18	23	21	3	7	14	7	21	12	2	1	***	21	14	-	4
840202	122749	3	40	65	21	19	23	21	7	1	14	7	21	12	0	2	***	21	13	-	4
840202	122849	3	40	65	21	19	23	20	4	6	13	7	21	12	1	1	***	19	12	-	4
840202	123149	3	39	63	21	19	23	20	6	1	13	7	20	11	1	2	***	17	10	-	4
840202	123649	3	38	61	20	18	22	19	5	2	12	6	20	10	1	2	***	13	6	-	5
840202	123949	3	36	60	20	17	22	19	4	2	10	4	19	9	3	4	***	11	5	-	5
840202	124549	3	33	57	19	16	22	18	4	2	8	2	19	9	3	4	***	7	2	-	5
840202	125549	3	31	53	19	15	20	17	2	2	6	0	18	8	3	5	***	4	1	-	5
840202	130749	3	29	48	18	14	20	16	2	0	5	0	17	7	2	4	***	1	3	-	5
840202	132049	3	27	44	17	13	19	15	3	1	5	2	16	6	3	4	***	0	3	-	5
840202	132649	3	26	42	16	13	18	14	1	0	4	1	16	5	2	4	***	1	4	-	5
840202	133049	3	25	41	16	13	18	14	4	1	5	3	16	6	3	4	***	1	4	-	4
840202	133149	3	25	40	16	13	18	14	3	1	5	2	16	6	2	3	***	1	4	-	5
840202	133449	3	25	40	15	13	17	14	2	0	4	3	16	5	2	4	***	1	4	-	4
840202	133649	3	24	39	15	13	17	14	4	1	4	3	16	5	1	3	***	2	4	-	5
840202	134149	3	23	38	14	13	16	13	1	1	4	4	15	5	2	3	***	1	4	-	4
840202	135849	3	21	33	14	11	15	12	1	2	4	2	14	4	3	4	***	3	4	-	4
840202	141949	3	19	29	13	10	14	11	4	2	4	2	14	4	3	4	***	3	4	-	5
840202	143349	3	18	27	13	10	14	11	2	3	5	4	14	4	3	5	***	3	4	-	5
840202	144349	3	22	20	14	14	12	14	1	2	0	1	13	4	1	3	***	4	5	-	5
840202	144449	3	26	22	18	18	13	18	3	3	0	1	13	4	1	3	***	4	5	-	6
840202	144649	3	30	26	25	24	14	24	0	4	0	2	13	4	2	2	***	4	5	-	6
840202	144849	3	28	26	24	23	17	24	3	4	1	2	13	4	4	3	11	3	4	-	5
840202	145149	3	32	30	26	25	23	26	1	5	1	4	13	4	6	4	8	4	4	-	5
840202	145349	3	30	29	27	24	23	25	5	5	2	4	13	3	5	4	6	4	4	-	5
840202	150349	3	27	29	26	23	26	24	9	7	6	8	12	3	4	4	2	3	4	-	5
840202	152049	3	25	28	24	21	25	20	9	8	10	12	11	3	5	4	2	4	4	-	5
840202	160149	3	22	23	21	17	21	17	8	8	12	12	9	2	5	5	4	5	4	-	6
840202	160349	3	22	23	20	17	21	17	2	7	12	12	9	2	5	4	4	4	4	-	6
840202	161425	3	20	22	19	16	20	15	3	5	11	11	9	1	4	4	3	4	4	-	7
840202	170349	3	16	18	16	12	17	13	6	3	9	8	8	0	5	5	5	4	5	-	8
840202	174816	3	12	14	12	8	14	10	2	1	7	6	6	2	7	7	6	6	7	-	9
840202	183316	3	9	11	10	7	11	8	2	0	5	3	5	3	8	8	7	7	7	-	10
840202	183716	3	9	11	9	6	11	8	3	1	4	3	5	3	8	8	7	8	8	-	9
840202	200020	3	6	7	6	4	7	4	1	0	2	2	2	5	8	8	7	8	8	-	9
840202	215622	3	2	3	2	1	3	1	3	2	0	0	0	6	8	8	7	8	9	-	8

UNCLASSIFIED

/C-33

Table C-10 (Cont'd)

THERMOCOUPLE TEMPERATURES

840203	011922	3	-	1	-	1	-	2	-	2	-	1	-	2	-	4	-	4	-	3	-	3	-	3	-	6	-	8	-	8	-	7	-	8	-	8	-	6
840203	040622	3	-	3	-	3	-	4	-	3	-	4	-	5	-	5	-	4	-	4	-	4	-	4	-	6	-	4	-	4	-	6	-	5	-	7	-	4
840203	052522	3	-	3	-	4	-	4	-	4	-	3	-	4	-	4	-	4	-	4	-	4	-	4	-	4	-	2	-	2	-	3	-	2	-	3	-	2
840203	070222	3		7		4		1		1		3		0		1		2		1		3		3		2		1		1		1		1		2		1
840203	070822	3		2		5		1		1		0		0		0		2		2		3		2		2		1		1		1		1		2		1
840203	071822	3		2		7		3		0		4		1		1		2		2		2		2		2		1		1		1		1		1		1
840203	090548	3		10		6		5		4		2		5		0		1		0		2		2		3		2		2		2		2		2		4
840203	090648	3		16		12		9		9		2		9		1		0		0		2		2		2		2		2		2		2		2		4
840203	090748	3		20		16		13		13		3		13		2		0		0		2		2		2		2		2		2		2		2		4
840203	090948	3		26		22		19		19		5		19		2		0		0		2		2		2		2		2		2		1		2		4
840203	091148	3		30		26		25		24		9		24		0		1		1		1		2		2		2		2		2		2		2		4
840203	091348	3		35		29		29		29		13		29		4		2		2		0		3		3		3		3		3		2		2		4
840203	091548	3		38		33		33		33		19		33		6		4		3		1		2		2		2		2		2		2		2		4
840203	091748	3		42		37		37		36		22		36		8		5		3		2		3		2		3		3		3		2		2		4
840203	091948	3		45		42		40		39		26		40		10		6		4		4		2		2		2		2		3		2		2		4

UNCLASSIFIED

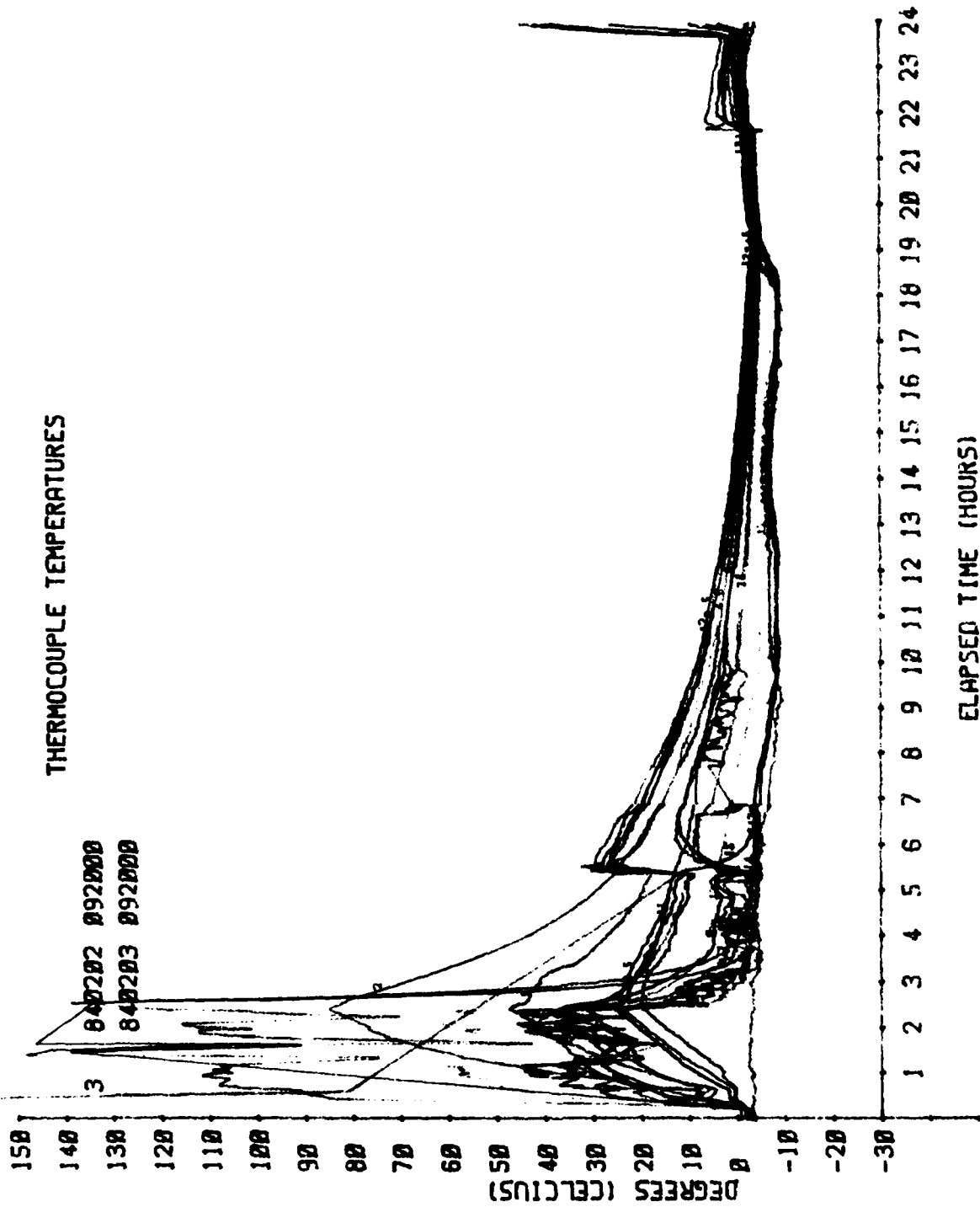


Figure C-10

UNCLASSIFIED

/C - 35

**STARTING DATA FROM
VEHICLE HEATED WITH
HOT AIR AND HEATER EXHAUST**

UNCLASSIFIED

UNCLASSIFIED

/C-36

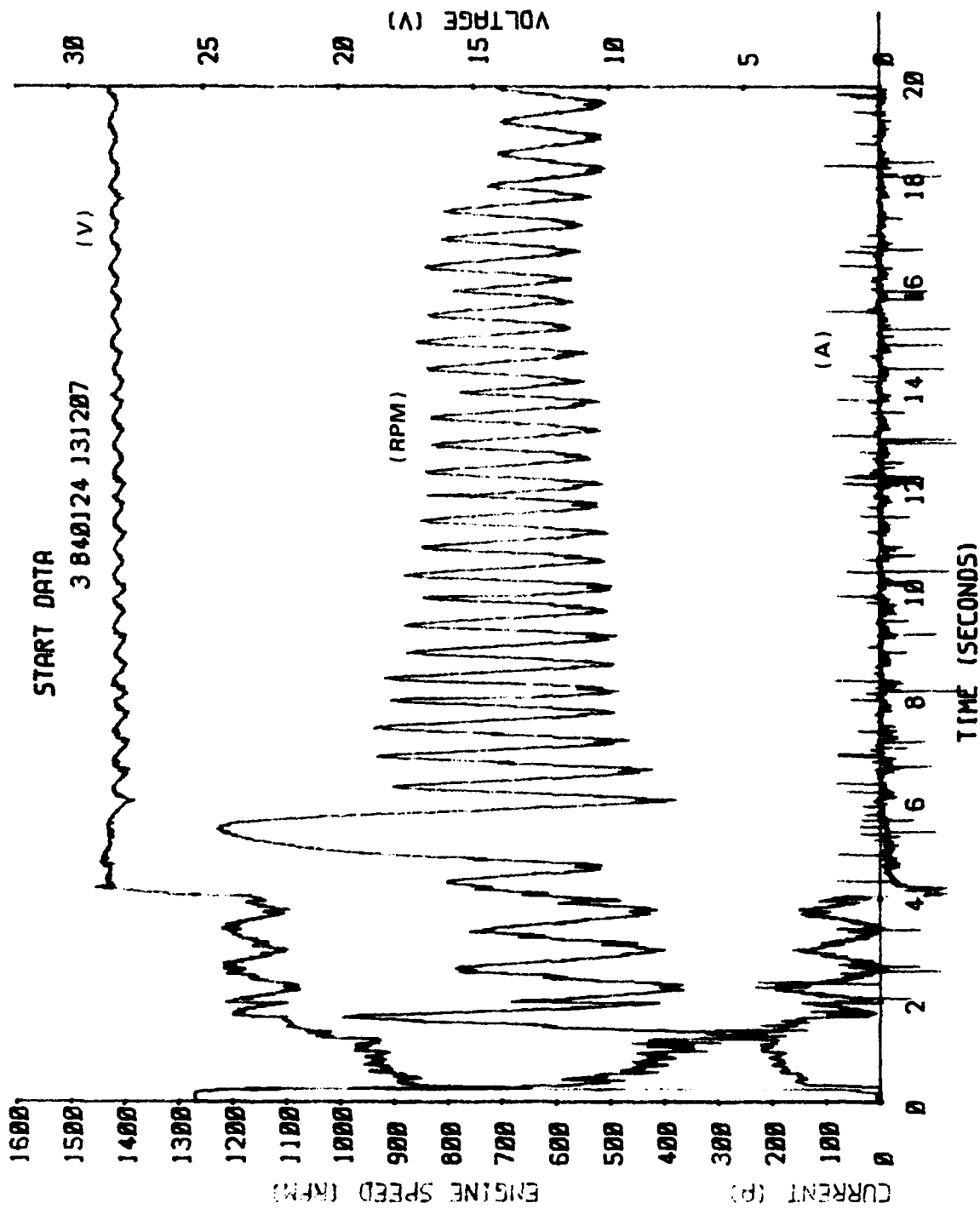


Figure C-11

UNCLASSIFIED

UNCLASSIFIED

/C-37

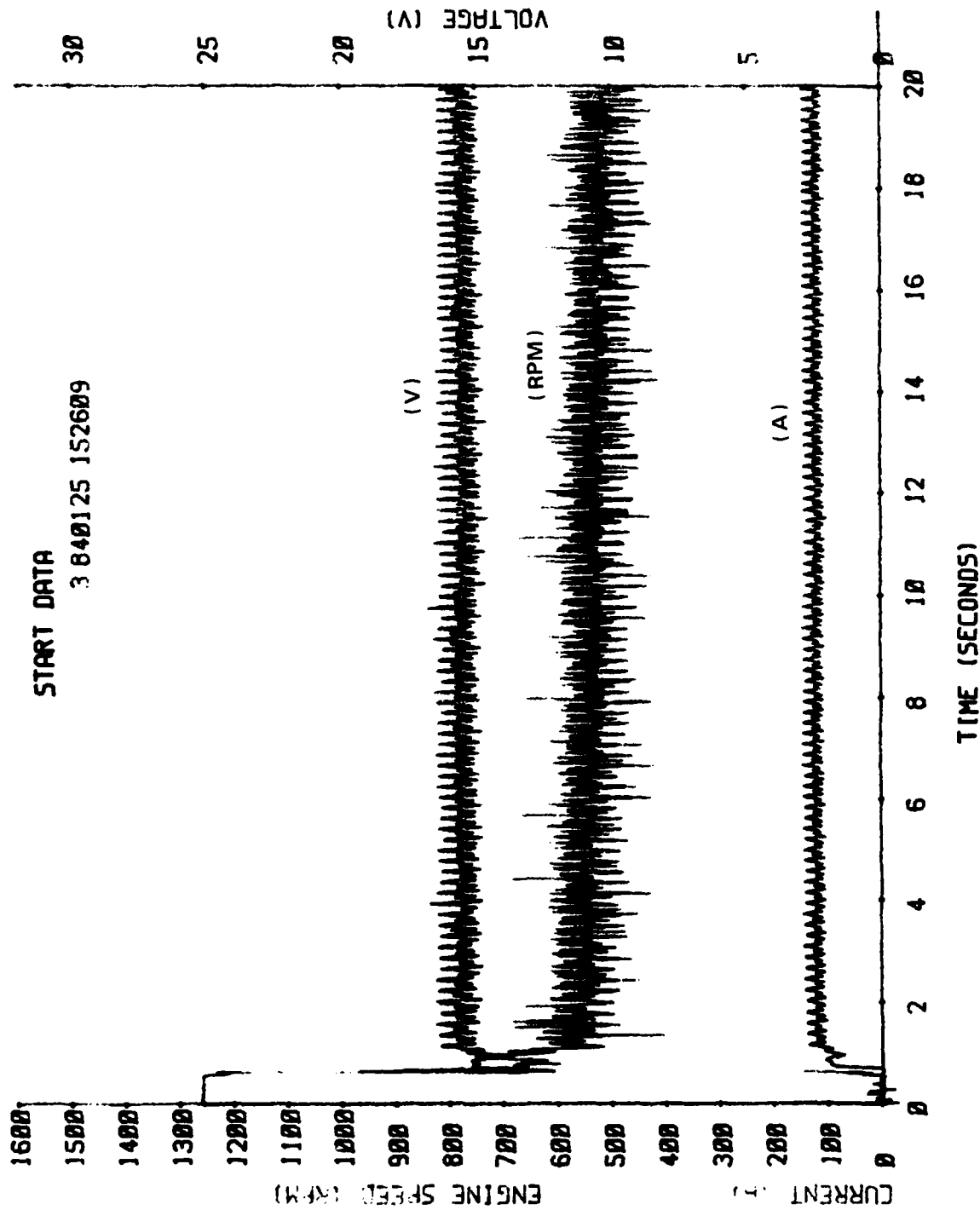


Figure C-12

UNCLASSIFIED

UNCLASSIFIED

/C-38

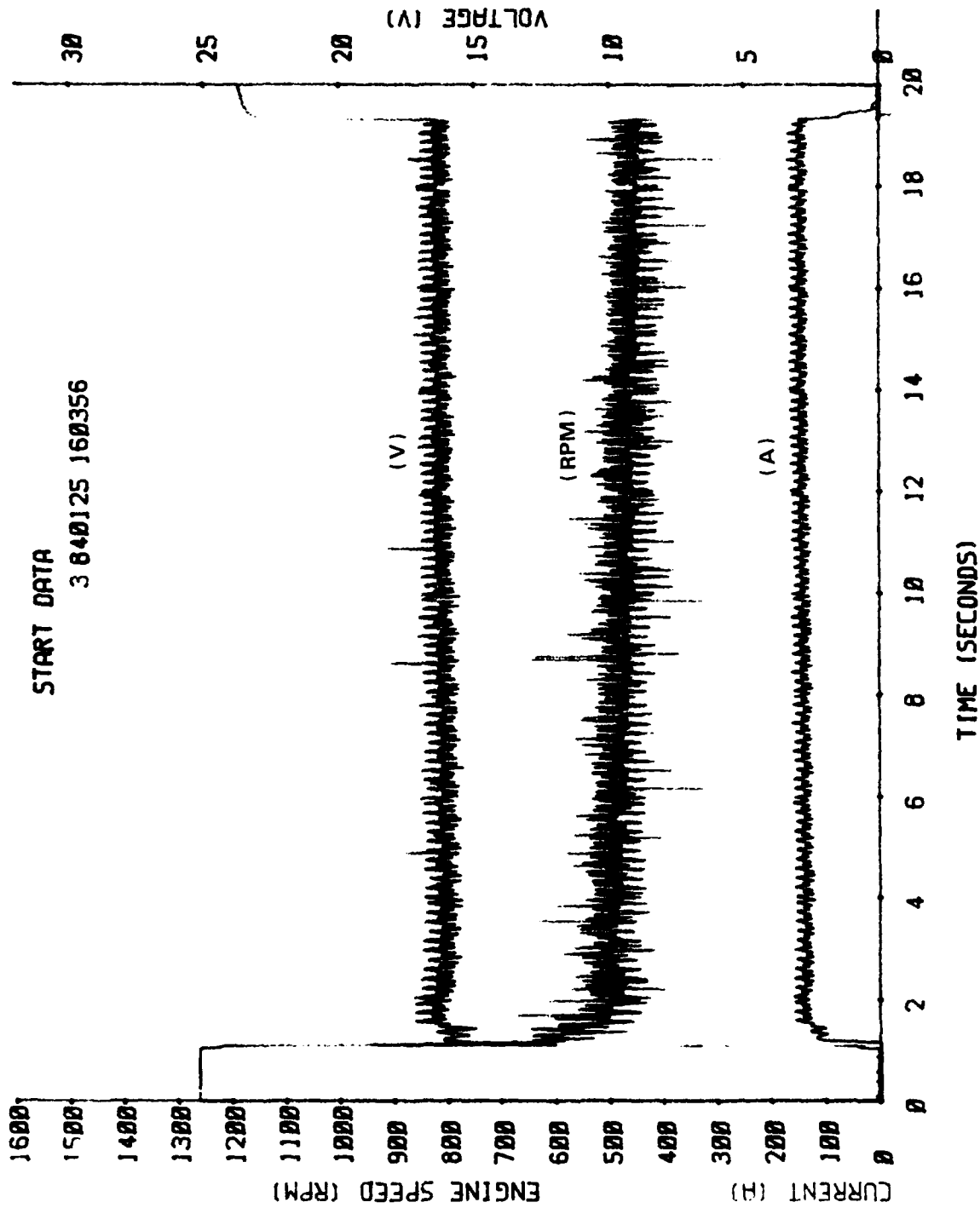


Figure C-13

UNCLASSIFIED

/C-39

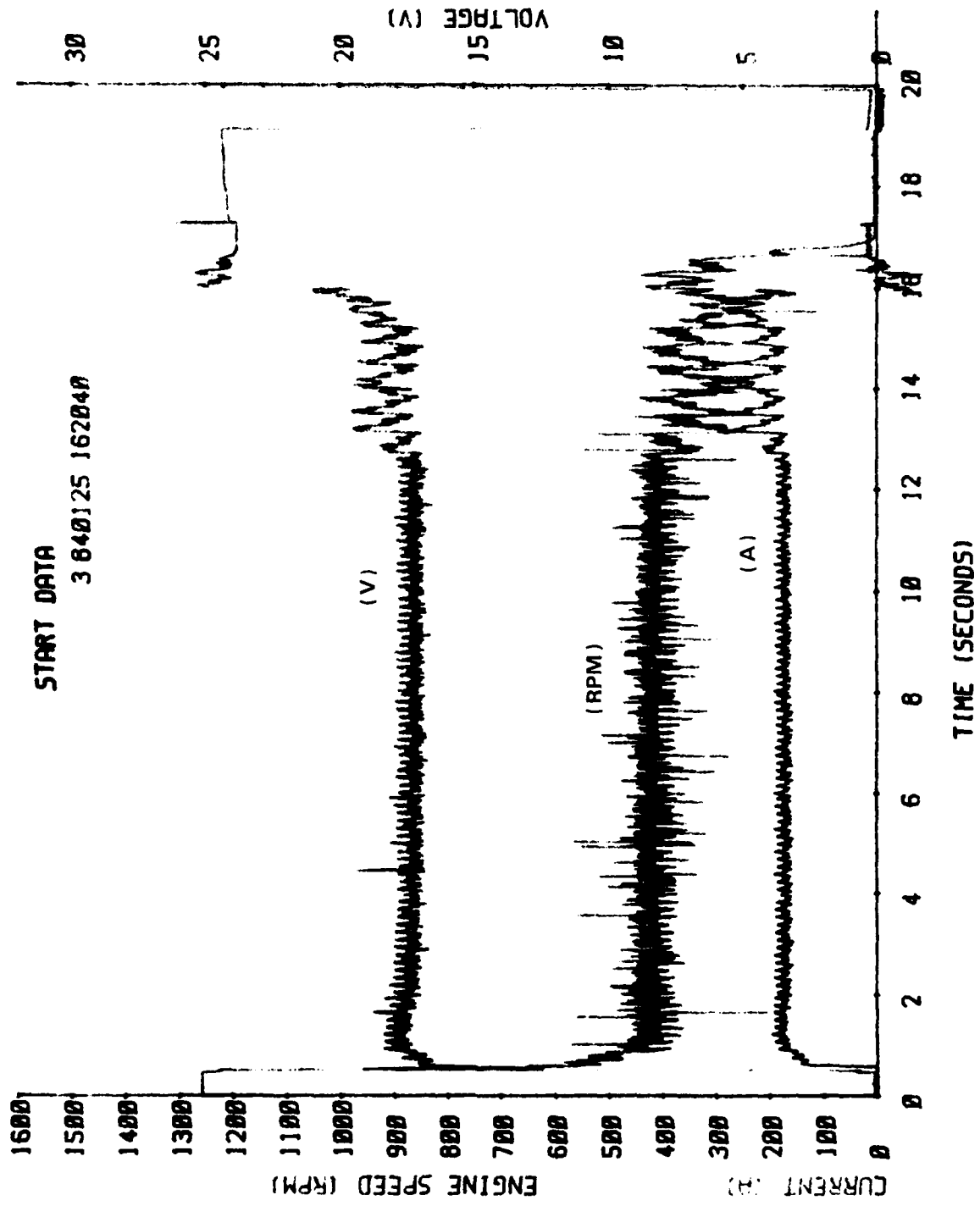


Figure C-14

UNCLASSIFIED

UNCLASSIFIED

/C-40

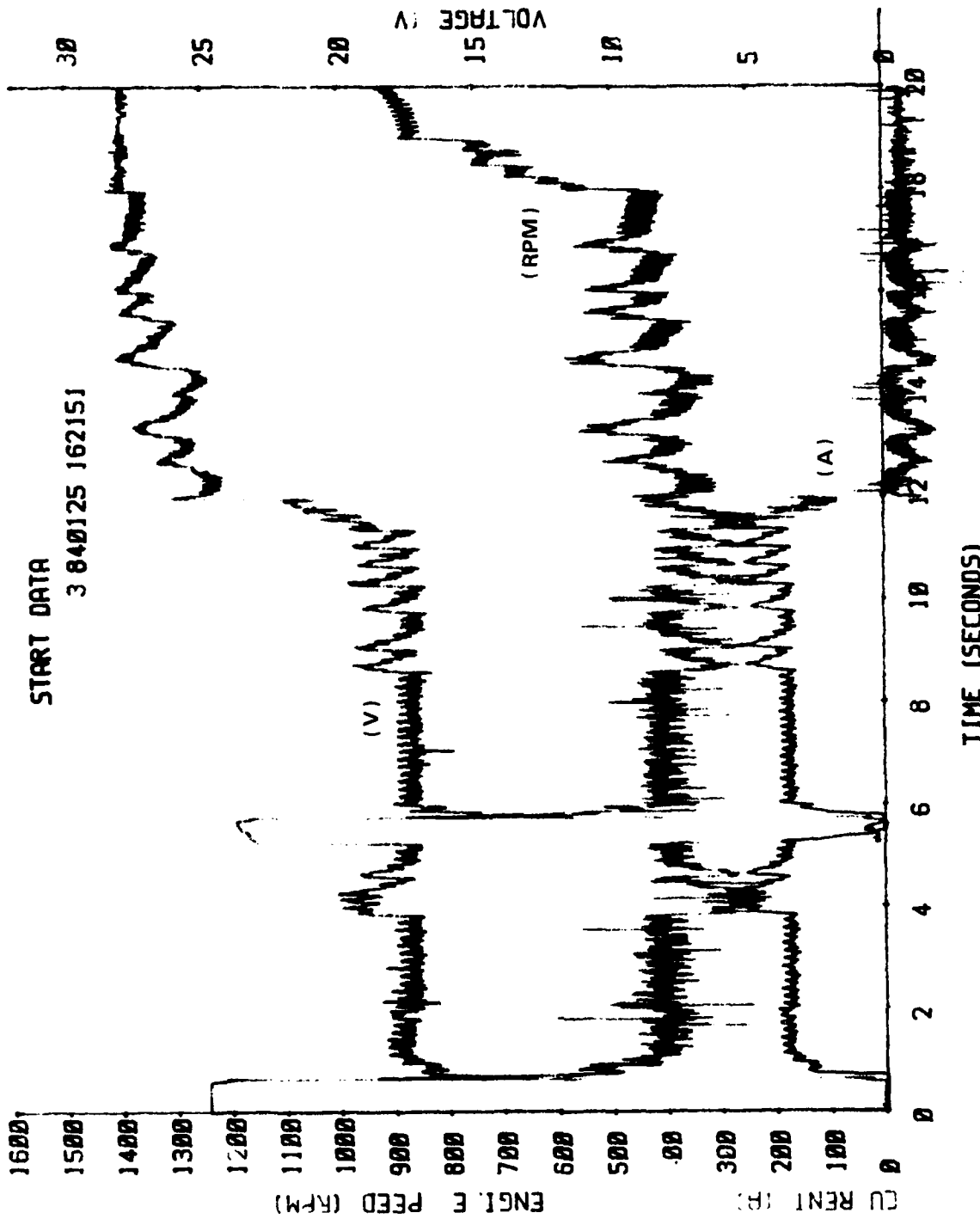


Figure C-15

UNCLASSIFIED

UNCLASSIFIED

/C-41

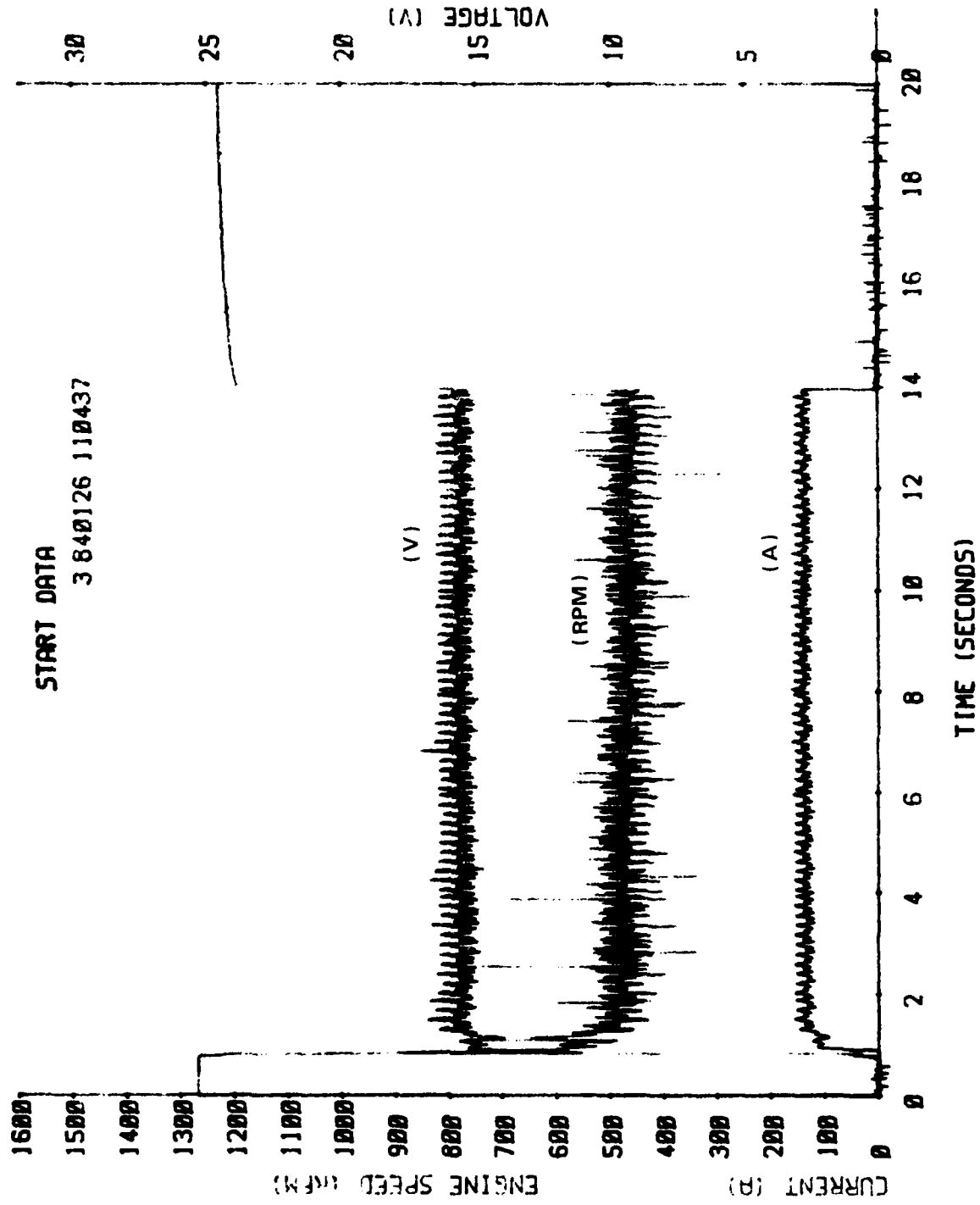


Figure C-16

UNCLASSIFIED

UNCLASSIFIED

/C-42

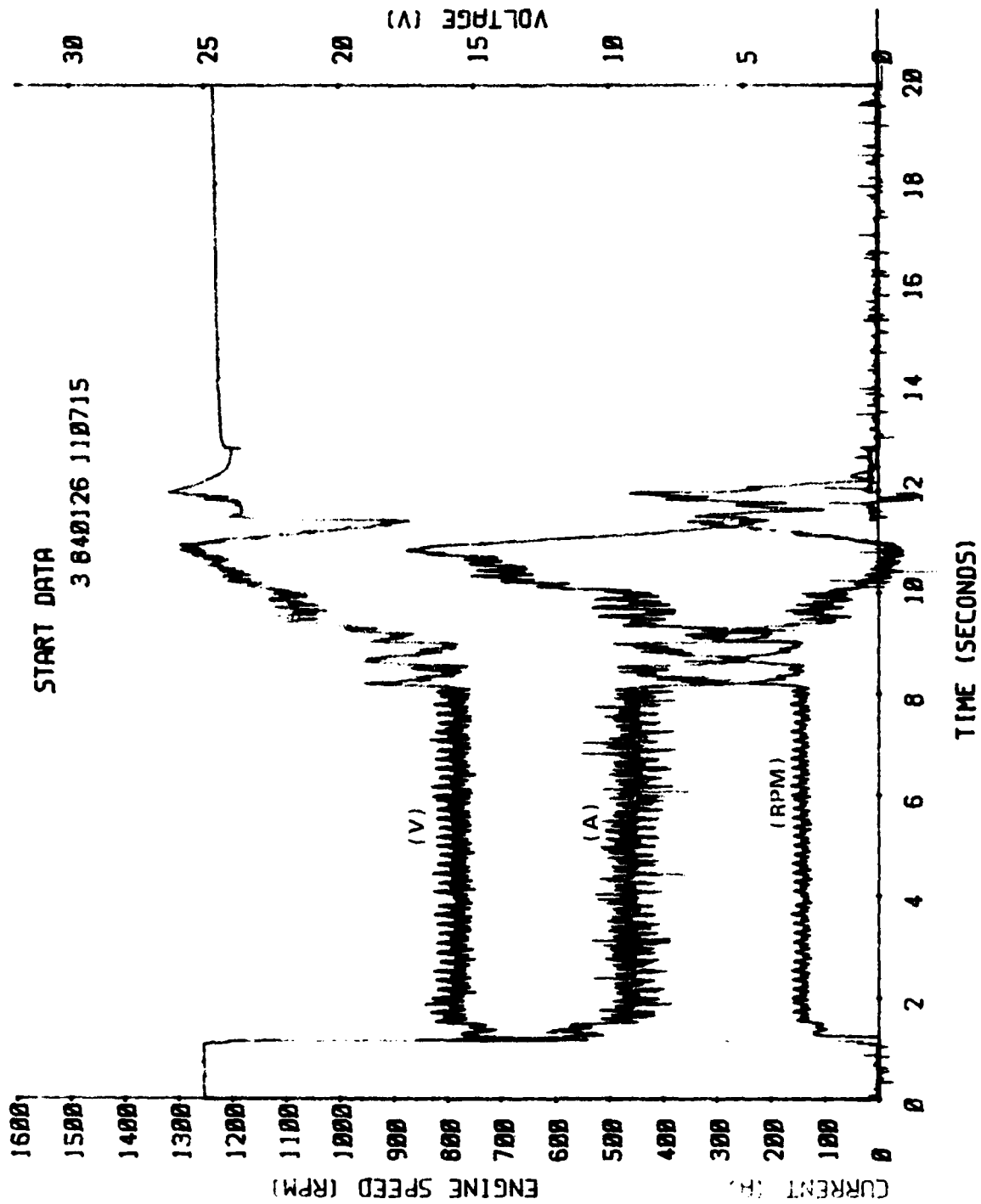


Figure C-17

UNCLASSIFIED

/C-43

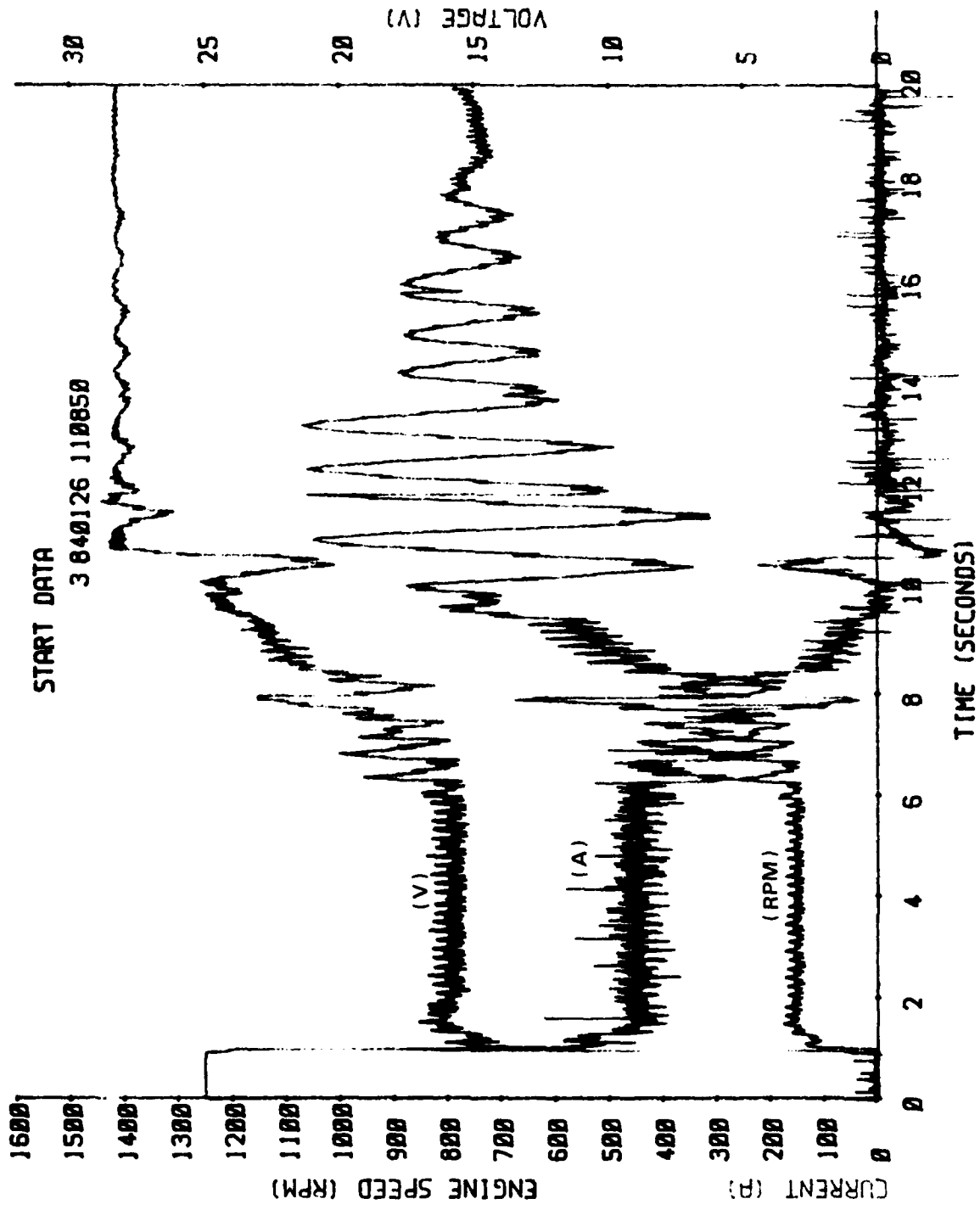


Figure C-18

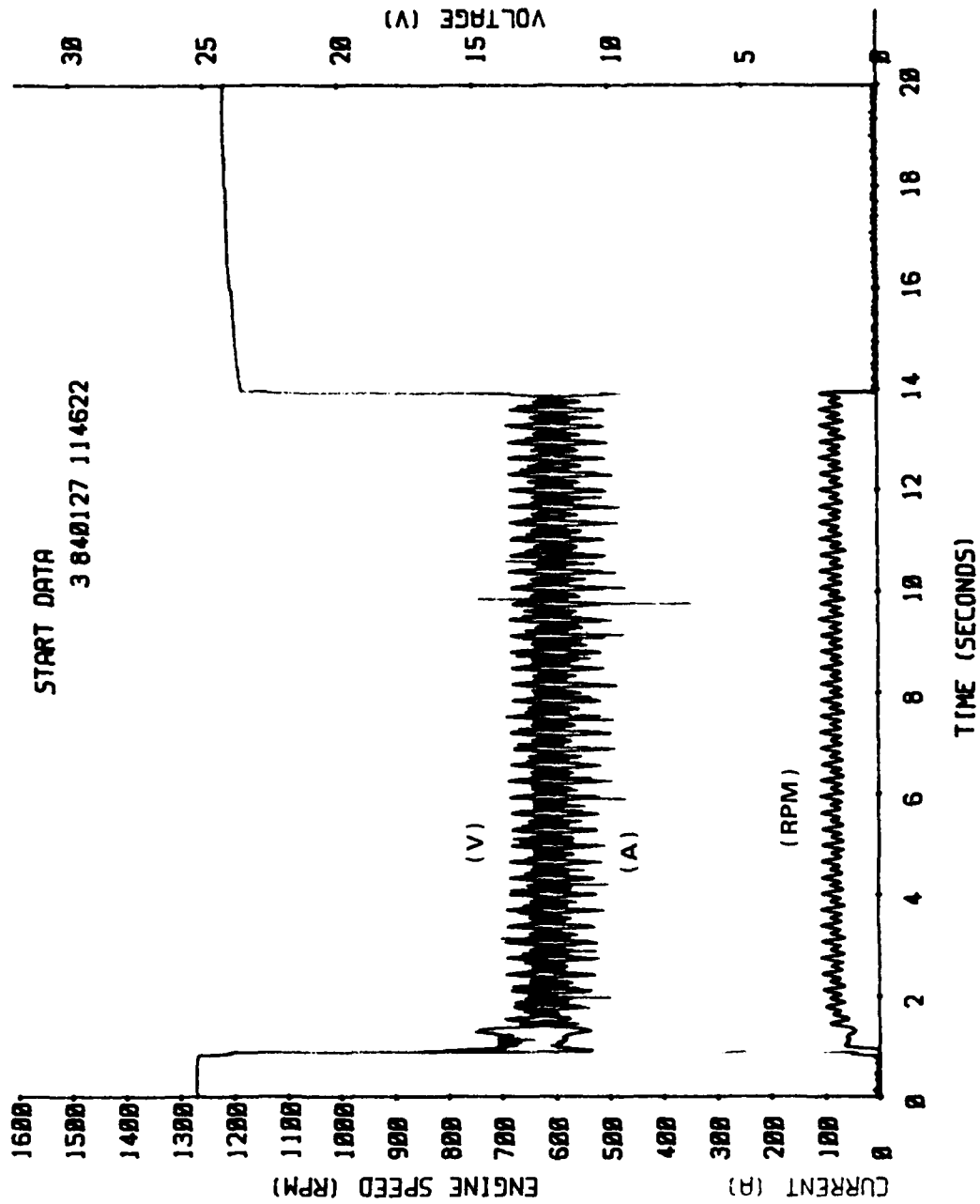


Figure C-20

UNCLASSIFIED

/C-45

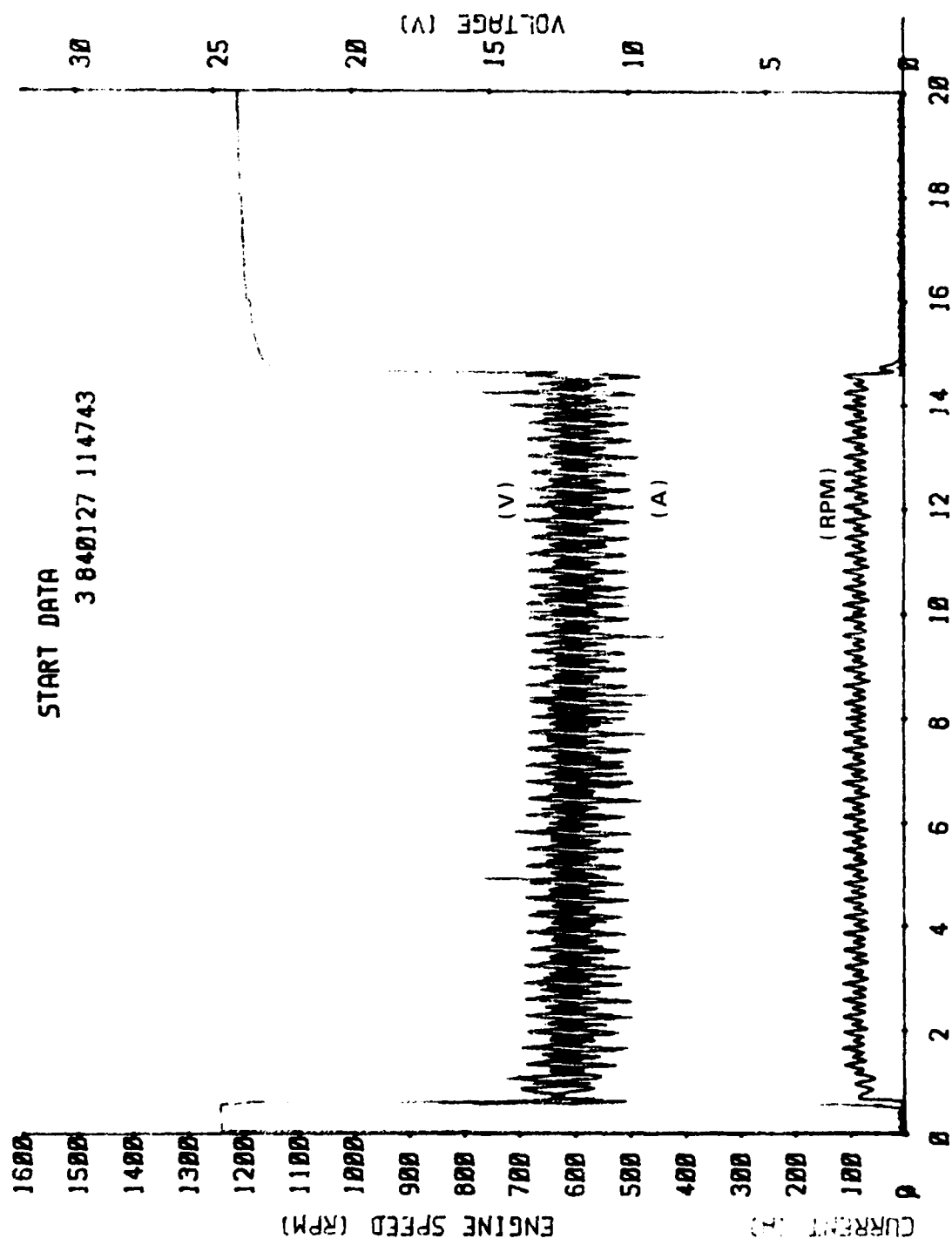


Figure C-21

UNCLASSIFIED

/C-46

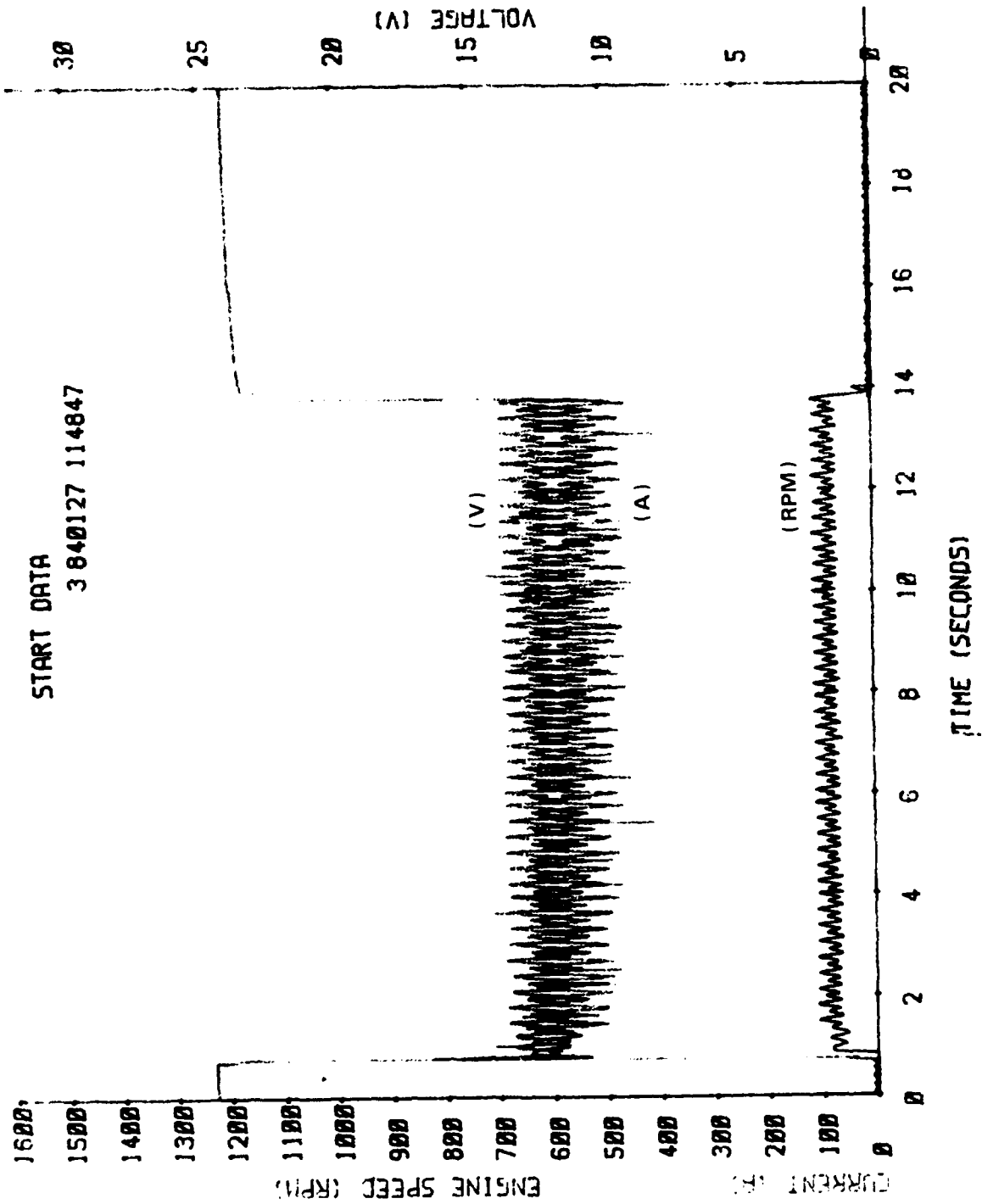


Figure C-20

UNCLASSIFIED

UNCLASSIFIED

/C-47

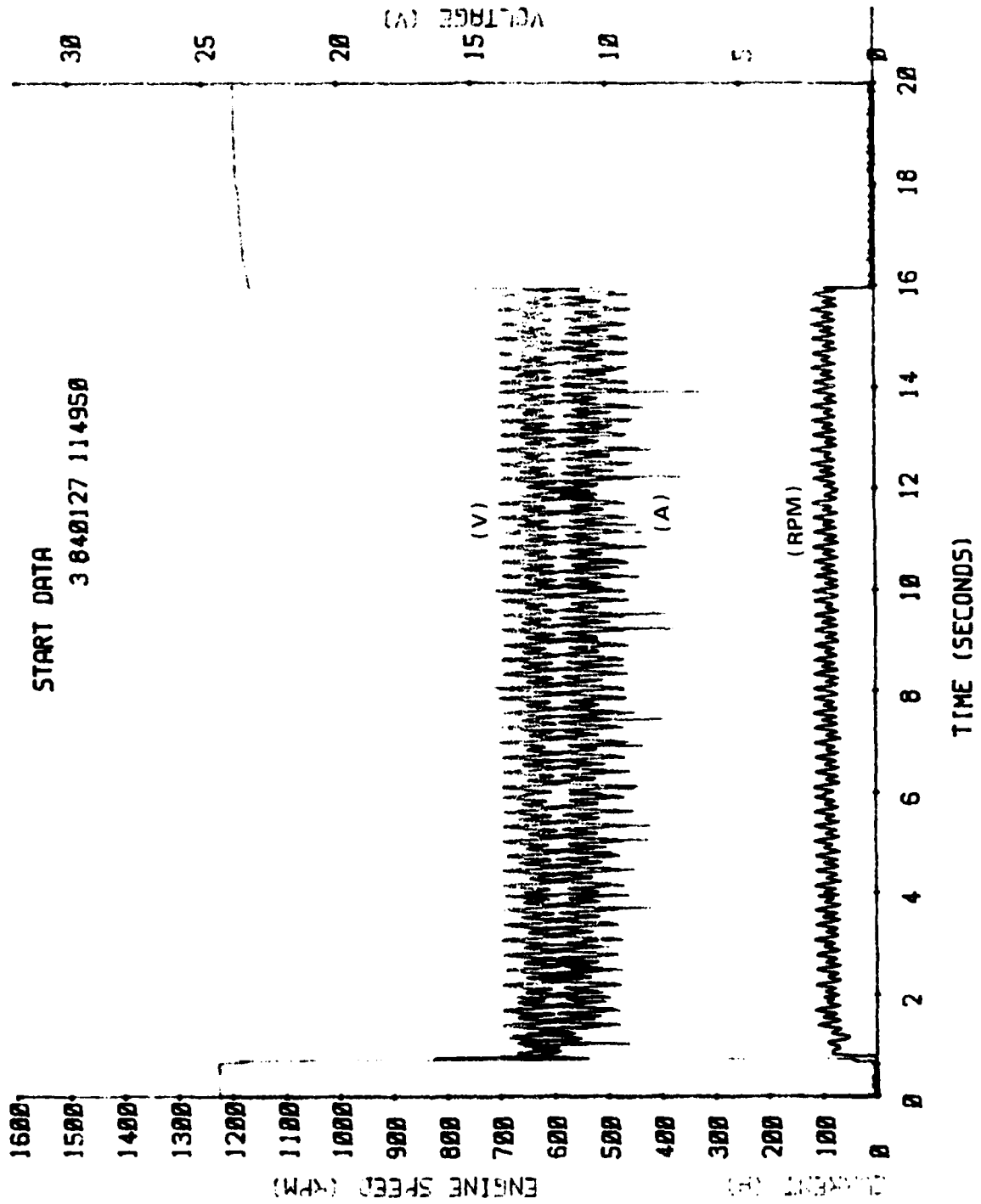


Figure C-22

UNCLASSIFIED

UNCLASSIFIED

/C-48

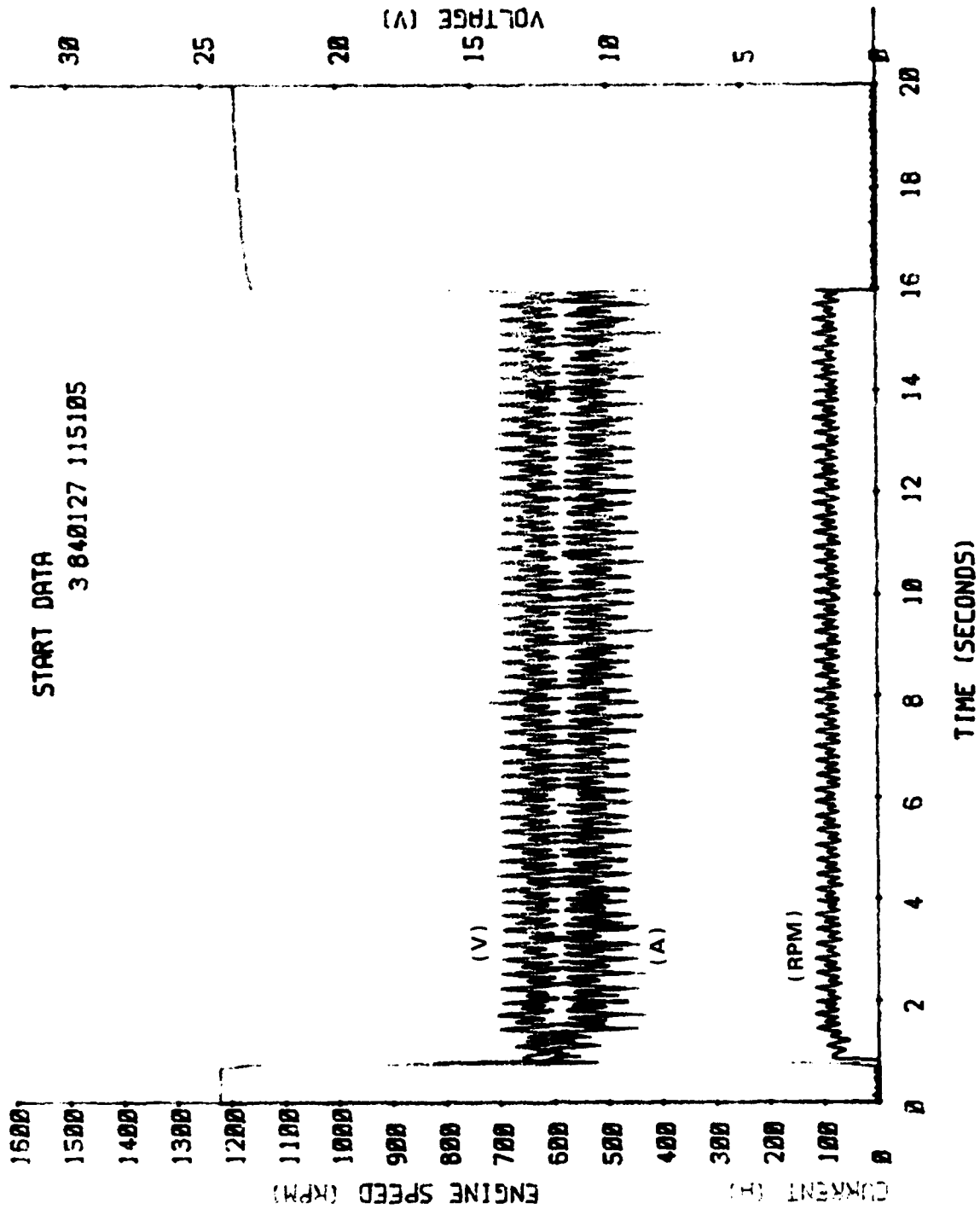


Figure C-23

UNCLASSIFIED

UNCLASSIFIED

/C-49

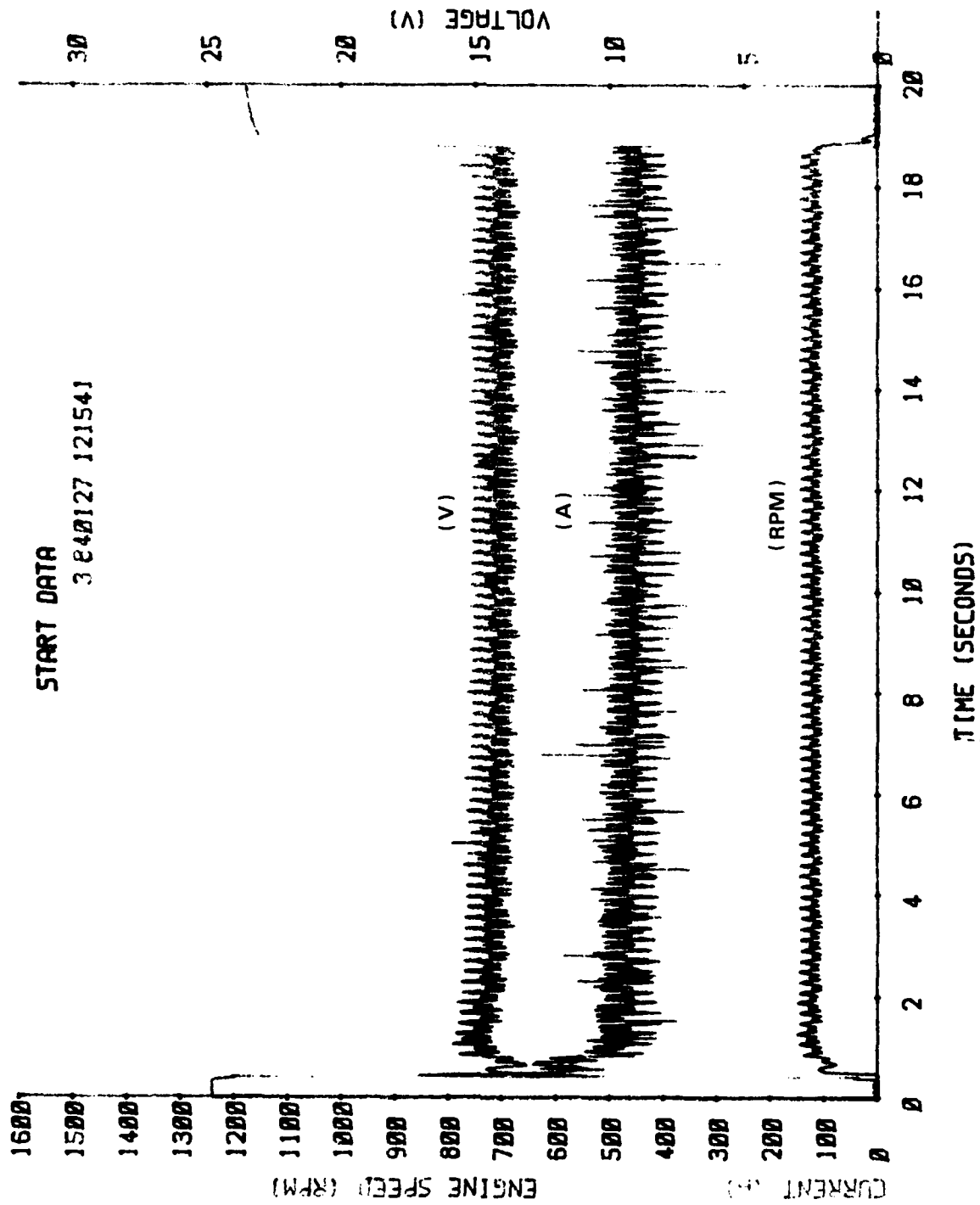


Figure C-24

UNCLASSIFIED

UNCLASSIFIED

/C-50

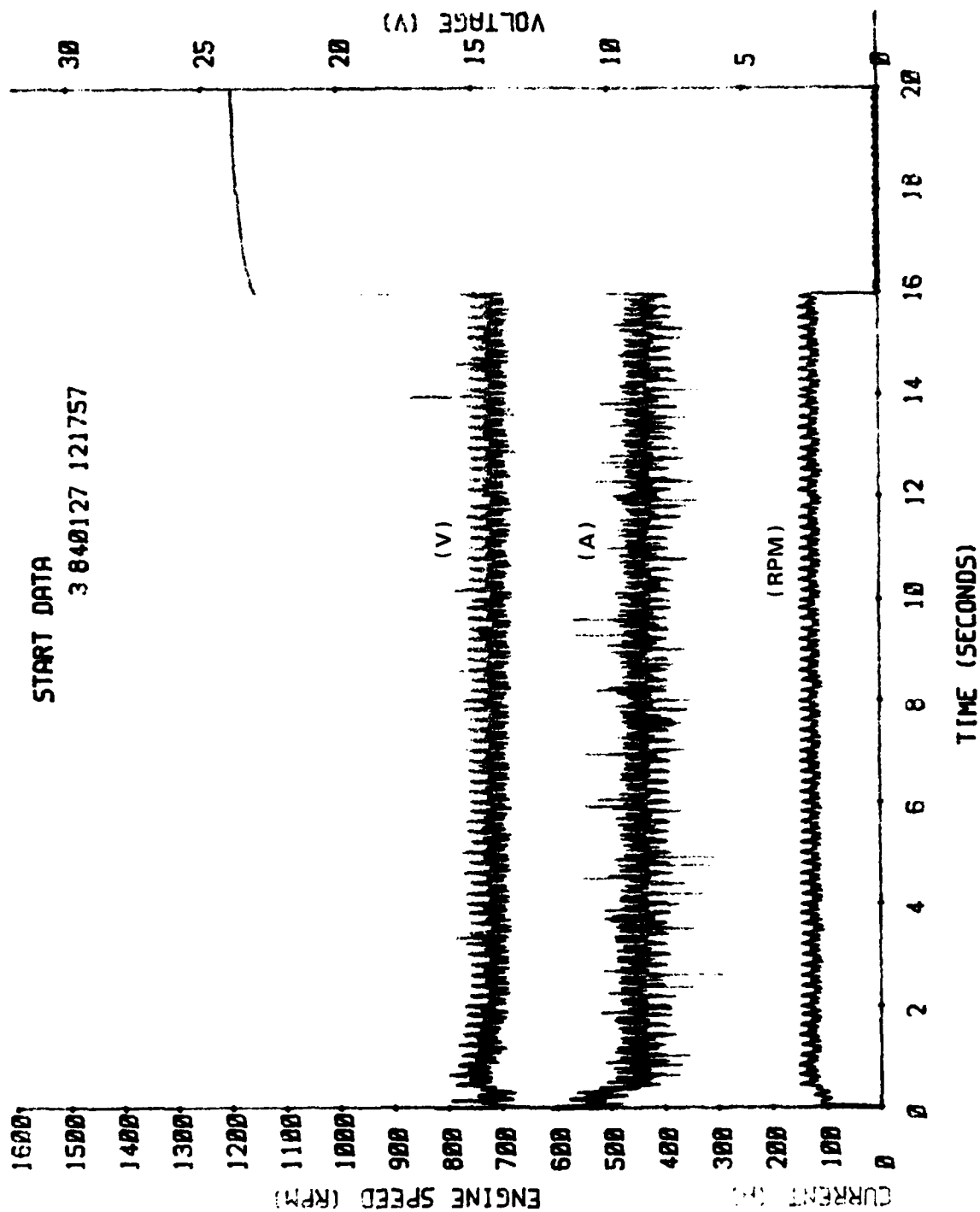
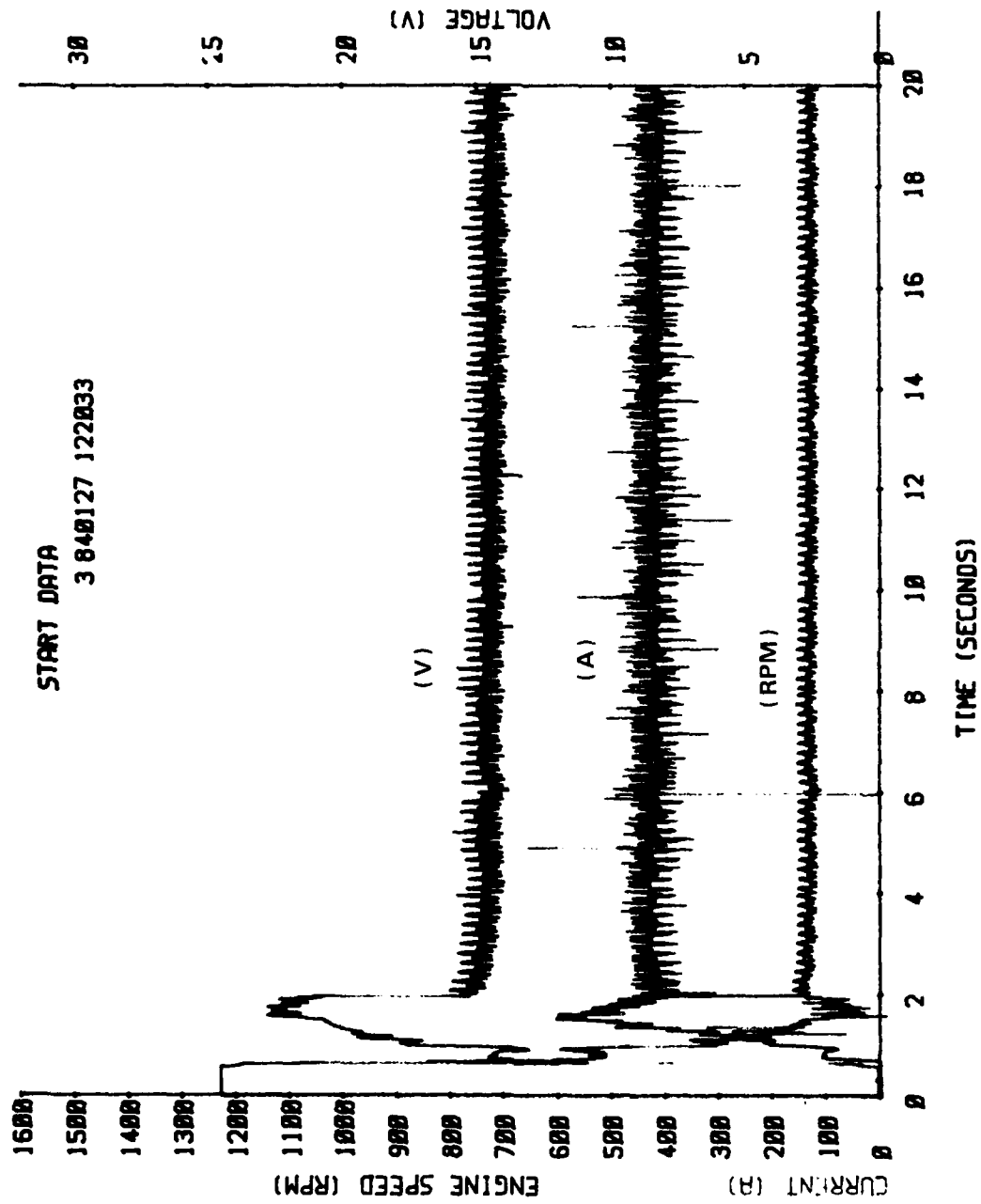


Figure C-25

UNCLASSIFIED



UNCLASSIFIED

Figure C-26

UNCLASSIFIED

/C-52

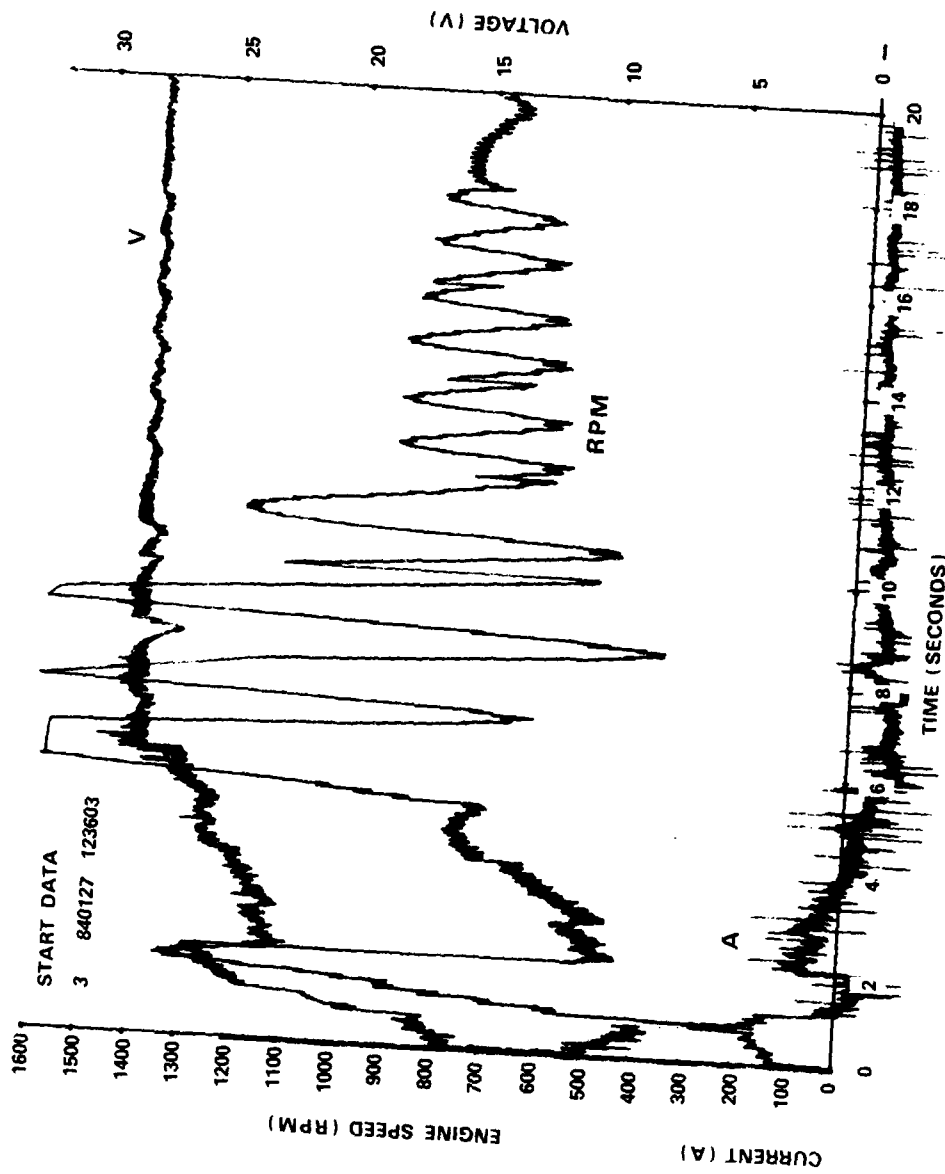


Figure C-27

UNCLASSIFIED

UNCLASSIFIED

/C-53

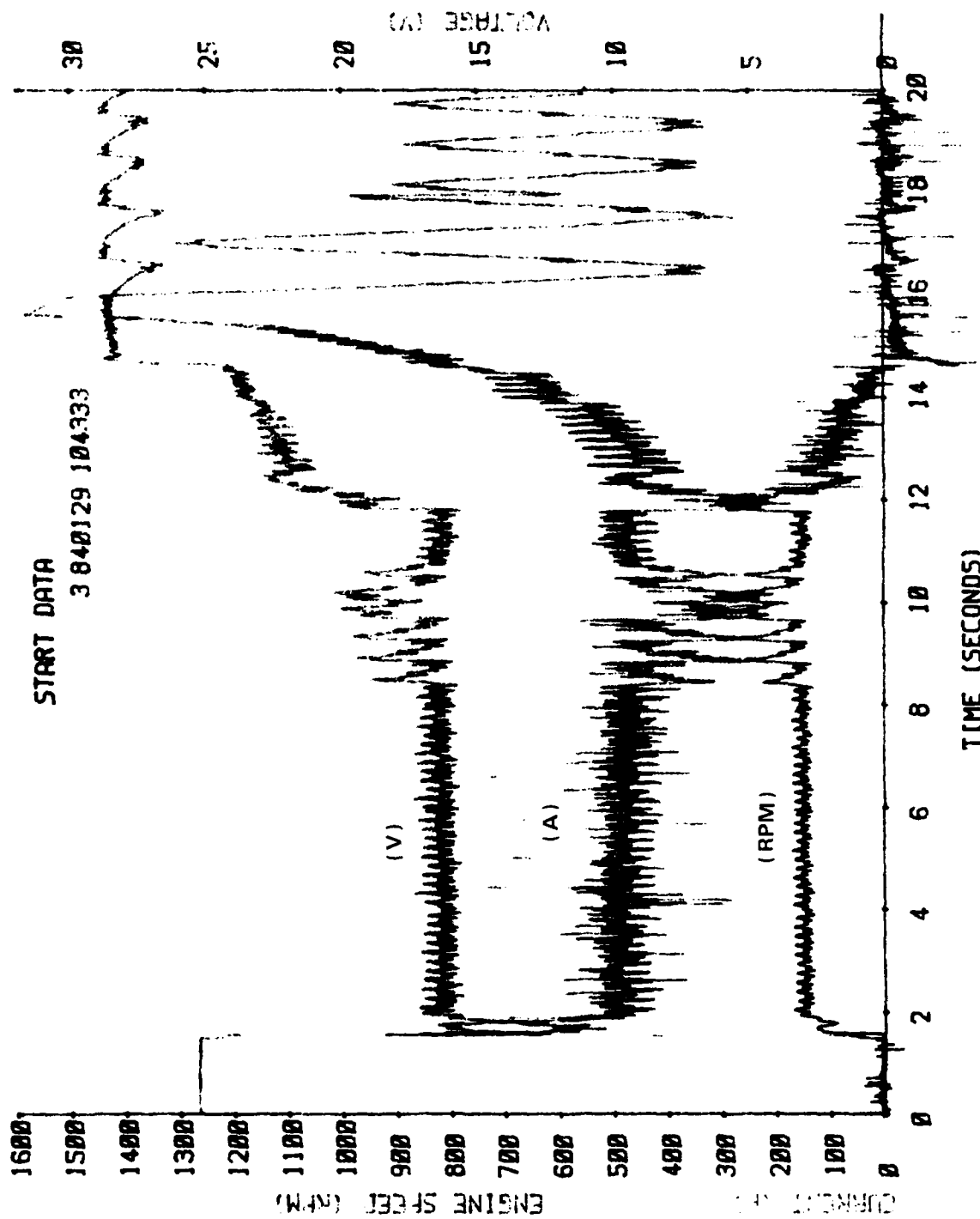


Figure C-28

UNCLASSIFIED

UNCLASSIFIED

/C-54

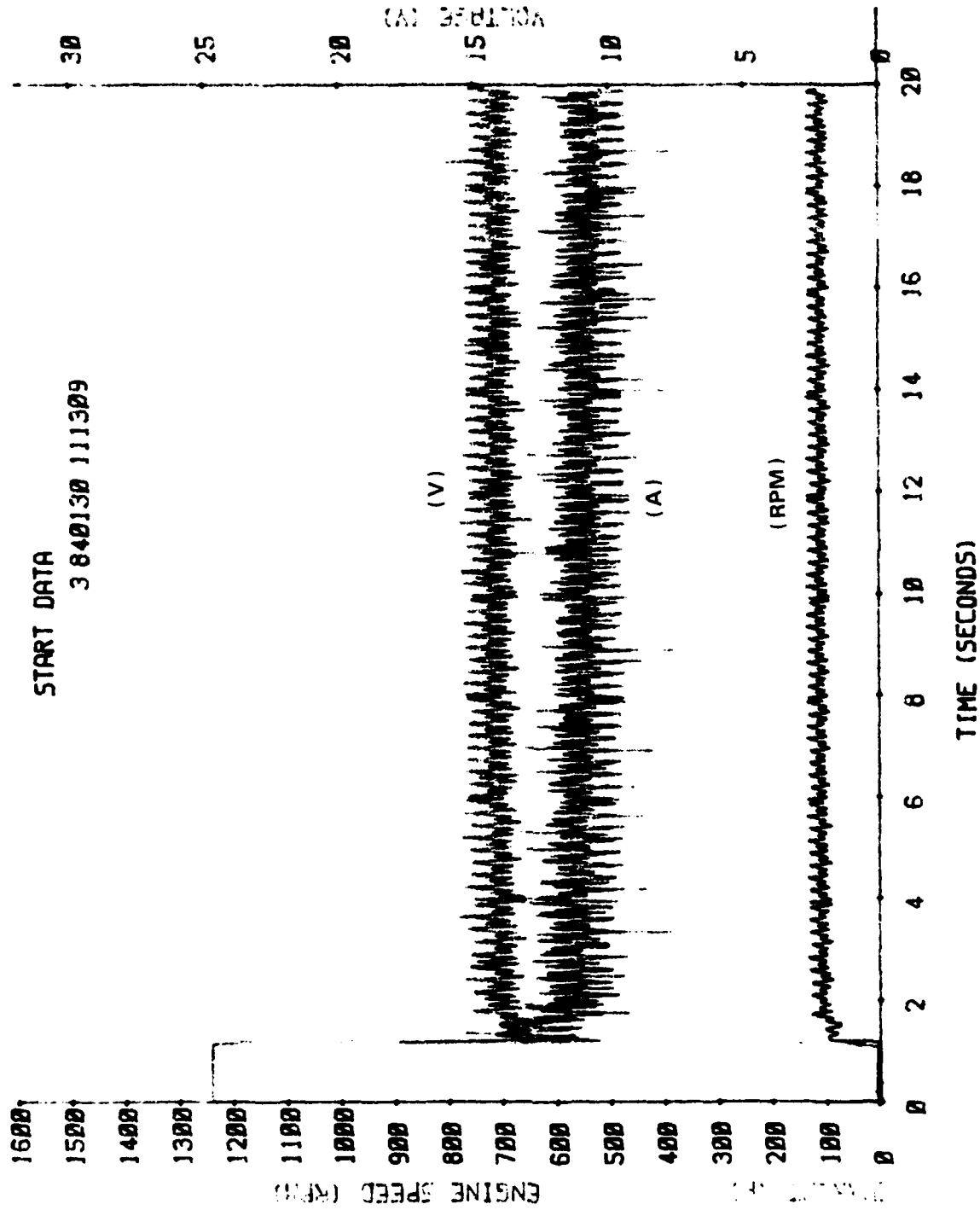


Figure C-29

UNCLASSIFIED

/C-55

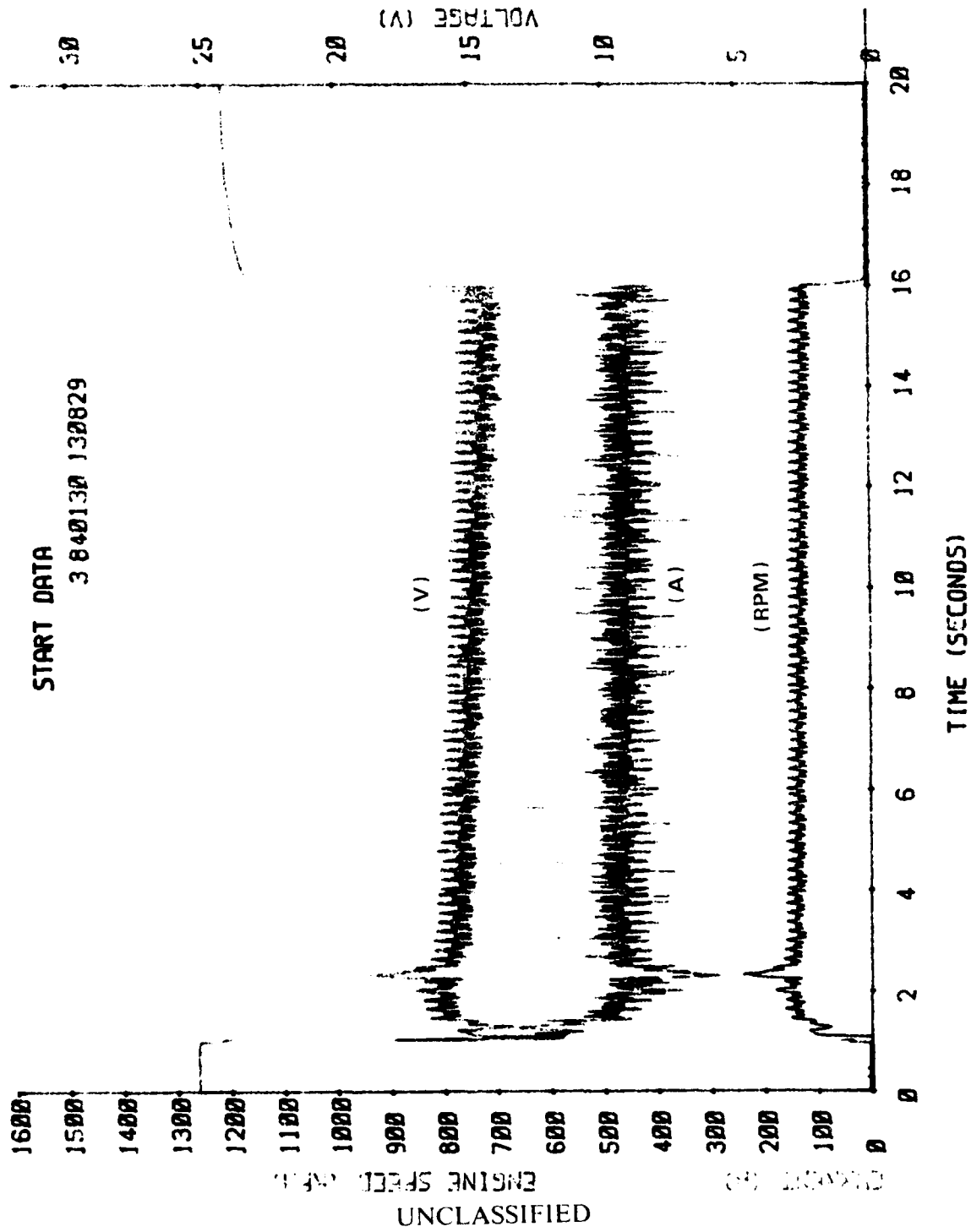
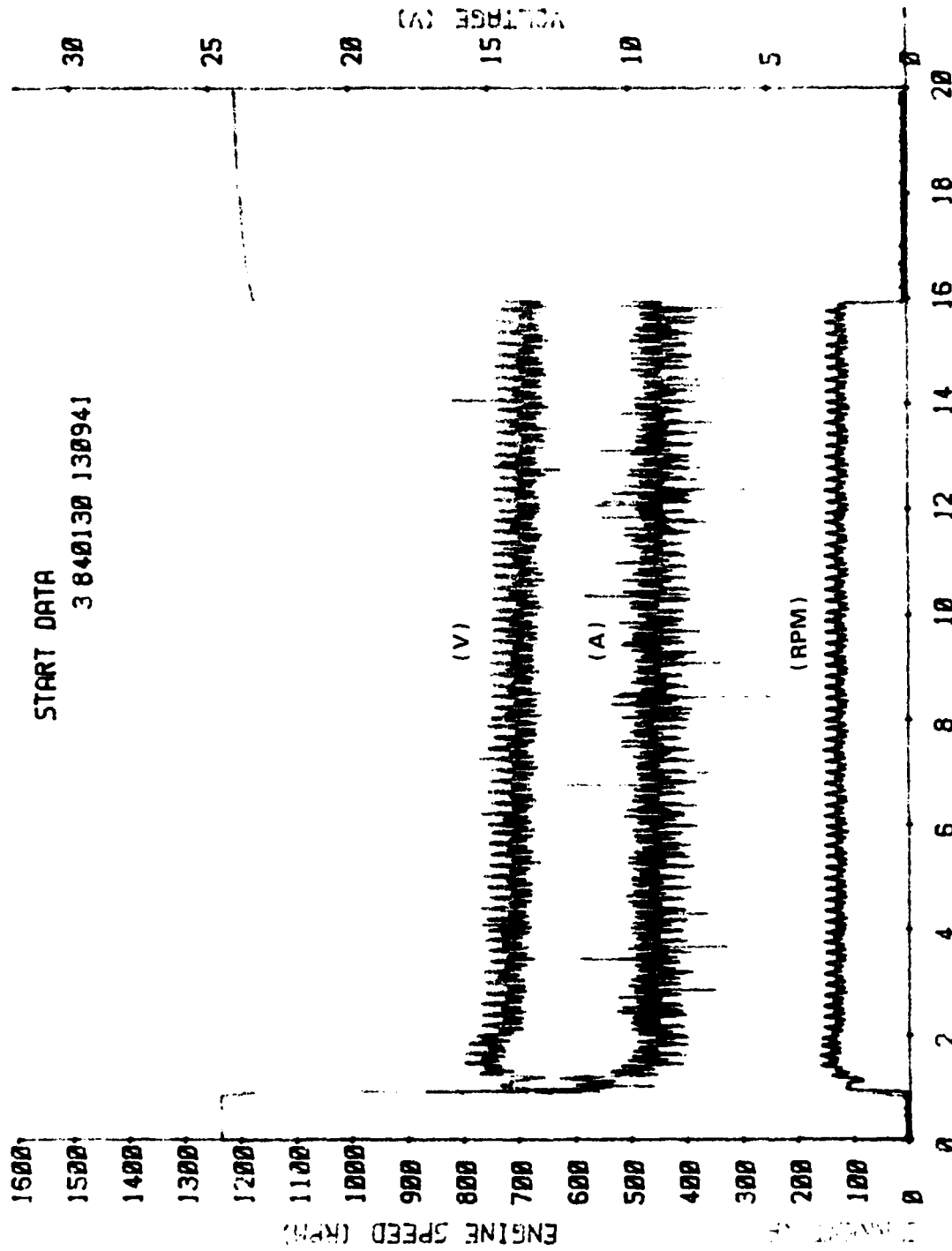


Figure C-30

UNCLASSIFIED

/C-56



UNCLASSIFIED

Figure C-31

UNCLASSIFIED

/C-57

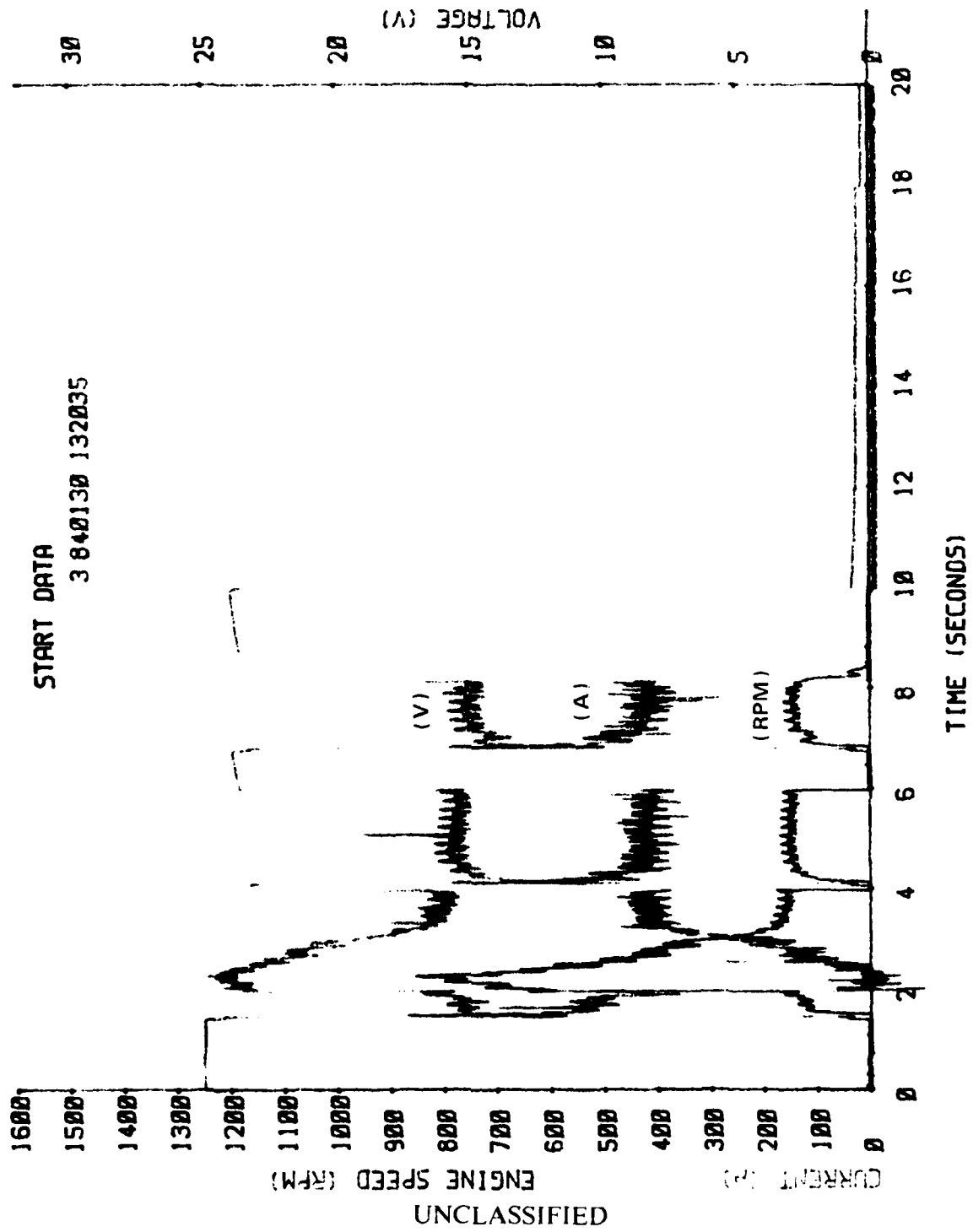


Figure C-32

UNCLASSIFIED

/C-58

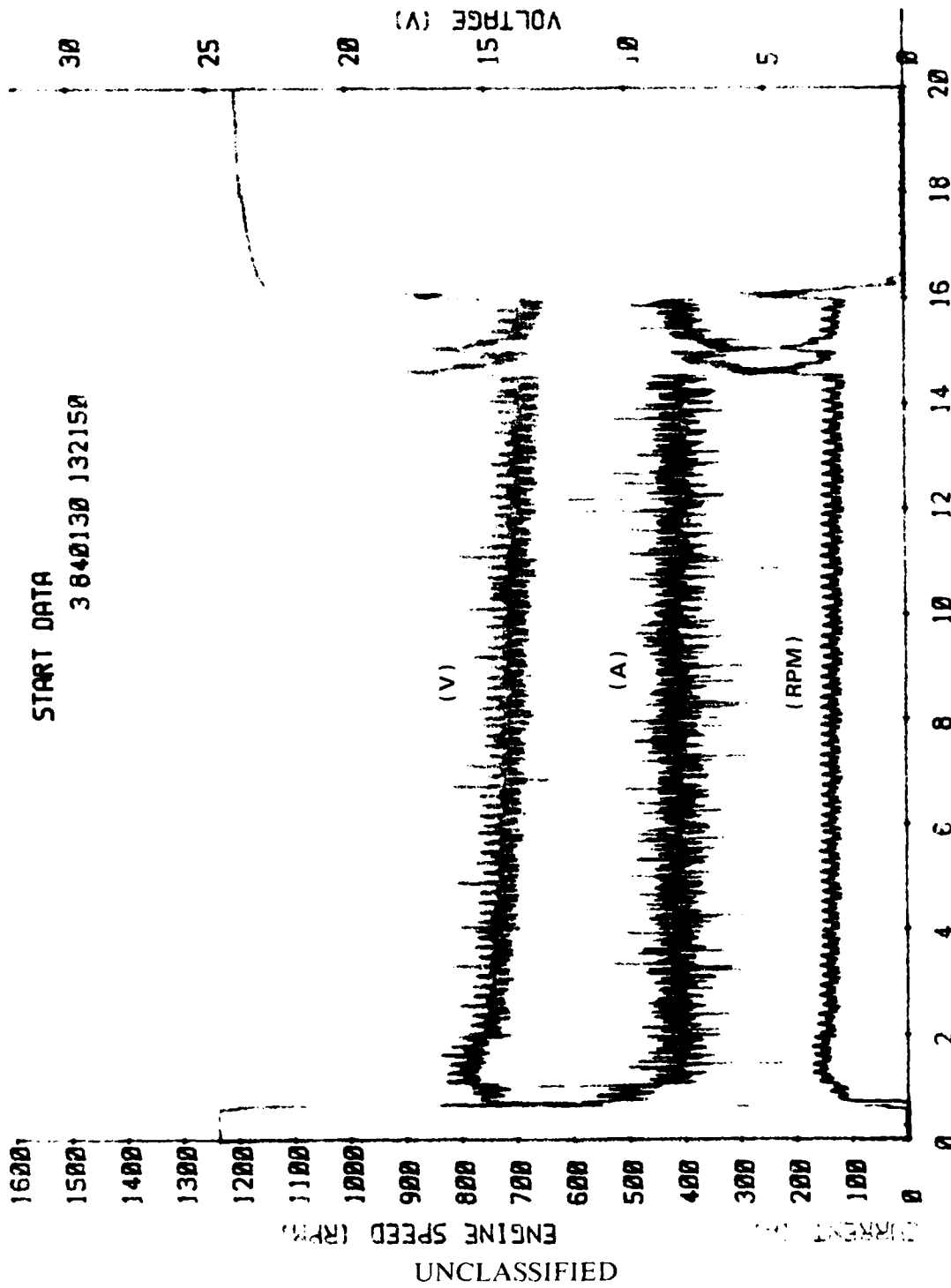


Figure C-33

UNCLASSIFIED

/C-59

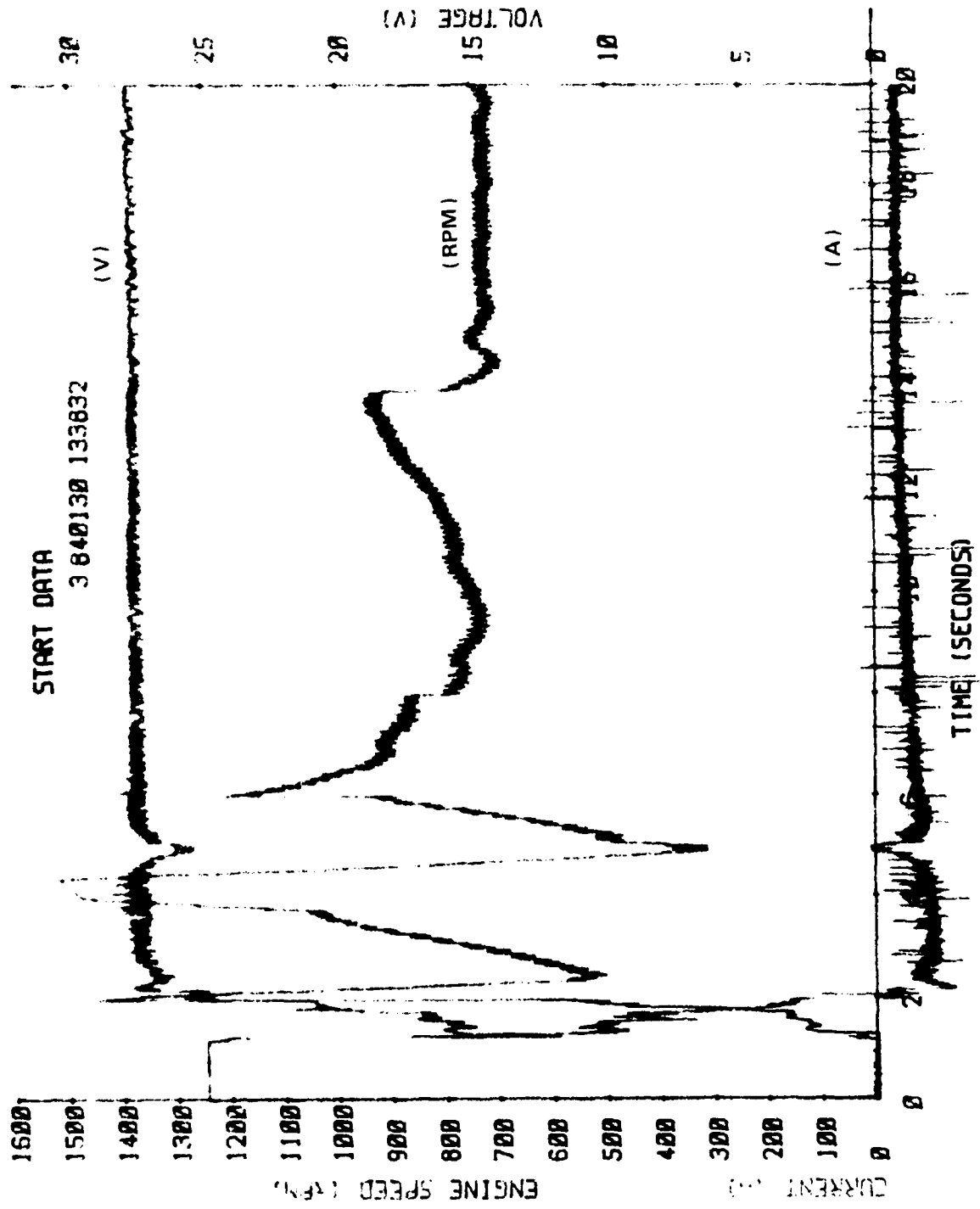


Figure C-34

UNCLASSIFIED

UNCLASSIFIED

ANNEX D

DATA FROM CONTROL VEHICLE

UNCLASSIFIED

INDEX FOR ANNEX D

	Page No.
Temperature Data from Control Vehicle	D- 5
Legend for Annex D Temperature Data	D- 6
Table D-1 840124, 111000 — 840125, 111000	D- 7
Figure D-1 840124, 111000 — 840125, 111000	D- 8
Table D-2 840125, 104500 — 840126, 104500	D- 9
Figure D-2 840125, 104500 — 840126, 104500	D-10
Table D-3 840126, 100000 — 840127, 100000	D-11
Figure D-3 840126, 100000 — 840127, 100000	D-12
Table D-4 840127, 095000 — 840128, 095000	D-13
Figure D-4 840127, 095000 — 840128, 095000	D-14
Table D-5 840128, 095000 — 840129, 095000	D-15
Figure D-5 840128, 095000 — 840129, 095000	D-16
Table D-6 840129, 100000 — 840130, 100000	D-17
Figure D-6 840129, 100000 — 840130, 100000	D-19
Table D-7 840130, 125000 — 840131, 125000	D-20
Figure D-7 840130, 125000 — 840131, 125000	D-22
Table D-8 840131, 095000 — 840201, 095000	D-23
Figure D-8 840131, 095000 — 840201, 095000	D-24
Table D-9 840201, 095000 — 840202, 095000	D-25
Figure D-9 840201, 095000 — 840202, 095000	D-26
Table D-10 840202, 100000 — 840203, 100000	D-27
Figure D-10 840202, 100000 — 840203, 100000	D-28
Table D-11 840203, 090000 — 840204, 090000	D-29
Figure D-11 840203, 090000 — 840204, 090000	D-30
Table D-12 840204, 091000 — 840205, 091000	D-31
Figure D-12 840204, 091000 — 840205, 091000	D-32

INDEX FOR ANNEX D (Cont'd)

	<u>Page No.</u>
Table D - 13 840205, 115000 — 840206, 115000	D - 33
Figure D - 13 840205, 115000 — 840206, 115000	D - 35
Table D - 14 840206, 110000 — 840207, 110000	D - 36
Figure D - 14 840206, 110000 — 840207, 110000	D - 37
Table D - 15 840207, 075000 — 840208, 075000	D - 38
Figure D - 15 840207, 075000 — 840208, 075000	D - 39
Table D - 16 840208, 075000 — 840209, 075000	D - 40
Figure D - 16 840208, 075000 — 840209, 075000	D - 42
Table D - 17 840209, 092000 — 840210, 092000	D - 43
Figure D - 17 840209, 092000 — 840210, 092000	D - 44
Table D - 18 840210, 094500 — 840211, 094500	D - 45
Figure D - 18 840210, 094500 — 840211, 094500	D - 46
Starting Data from Control Vehicle	D - 47
Figure D - 19 840126, 104903	D - 48
Figure D - 20 840126, 105338	D - 49
Figure D - 21 840127, 100909	D - 50
Figure D - 22 840127, 101427	D - 51
Figure D - 23 840129, 101342	D - 52
Figure D - 24 840129, 101501	D - 53
Figure D - 25 840129, 101725	D - 54
Figure D - 26 840130, 143349	D - 55
Figure D - 27 840130, 143848	D - 56
Figure D - 28 840130, 155101	D - 57
Figure D - 29 840131, 125634	D - 58
Figure D - 30 840131, 125745	D - 59
Figure D - 31 840131, 125901	D - 60
Figure D - 32 840201, 095945	D - 61

INDEX FOR ANNEX D (Cont'd)

	<u>Page No.</u>
Figure D - 33 840204, 091519	D - 62
Figure D - 34 840204, 092033	D - 63
Figure D - 35 840205, 115841	D - 64
Figure D - 36 840206, 122117	D - 65
Figure D - 37 840207, 082333	D - 66
Figure D - 38 840208, 080624	D - 67
Figure D - 39 840209, 092951	D - 68
Figure D - 40 840209, 093122	D - 69
Figure D - 41 840209, 093241	D - 70
Figure D - 42 840210, 134534	D - 71
Figure D - 43 840210, 134645	D - 72

TEMPERATURE DATA FROM CONTROL VEHICLE

NOTE:

1. An unplugged thermocouple breaks the thermocouple circuit and causes the data acquisition system to measure common mode voltage which, in most cases, corresponds to a very high temperature. In those situations the temperature is far beyond the range used for actual temperature measurements and therefore the temperature is displayed in the tables as '***' and will not appear on the temperature plots except as a line descending directly down from a very high temperature to a legitimate reading. These occur on several occasions in Annex D but must be disregarded as they have absolutely no bearing on the temperatures which occurred in the vehicles.
2. Although temperature data was recorded at one minute intervals during the test period, to reduce the amount contained in this Annex, data is presented only after each change of 4°C in any thermocouple reading.

UNCLASSIFIED

/ D-6

LEGEND FOR ANNEX D TEMPERATURE DATA

1. Oil — Oil Pan, Rear
2. Coolant — Thermostat Housing
3. Air — Air Inlet Horn
4. Fuel — Fuel Inlet
5. Electrolyte — Battery, Forward
6. Air — Battery Box
7. Air — Crew Compartment
8. Air — Outside of Vehicle

UNCLASSIFIED

UNCLASSIFIED

/D-7

TABLE D-1

DATE	TIME	VEH	THERMOCOUPLE TEMPERATURES							
			1	2	3	4	5	6	7	8
840124	110213	4	- 1	- 0	- 1	- 1	- 4	- 2	- 1	1
840124	112024	4	6	3	1	- 2	- 3	- 2	- 1	1
840124	112124	4	19	10	3	3	3	2	- 1	1
840124	112424	4	26	18	4	- 4	- 3	- 2	- 1	1
840124	112524	4	37	28	6	- 4	- 3	- 2	- 1	1
840124	112624	4	43	36	8	- 4	- 3	- 2	- 0	1
840124	112724	4	47	38	9	- 4	- 2	- 1	- 0	1
840124	112924	4	52	42	10	- 4	- 2	- 1	- 0	2
840124	113124	4	59	47	12	- 4	- 2	- 1	- 0	2
840124	113324	4	62	52	13	- 3	- 2	- 1	- 1	1
840124	113524	4	67	57	15	- 3	- 2	- 1	0	1
840124	114013	4	71	63	18	- 2	- 1	- 0	0	2
840124	115031	4	75	67	23	- 1	- 1	1	1	5
840124	120057	4	76	68	31	17	0	2	2	1
840124	120357	4	75	67	32	22	0	2	2	2
840124	120657	4	75	66	33	27	0	2	2	3
840124	121057	4	74	65	34	32	0	2	2	2
840124	121657	4	73	64	35	36	1	3	2	2
840124	123057	4	68	61	38	40	2	4	2	1
840124	130406	4	63	58	32	18	4	6	3	2
840124	130706	4	62	57	33	23	3	6	3	1
840124	131006	4	62	56	34	27	3	6	3	1
840124	131506	4	61	55	35	31	4	6	3	0
840124	132606	4	60	54	36	35	4	6	3	0
840124	134406	4	55	52	35	36	5	7	4	- 1
840124	140706	4	51	49	34	35	5	7	4	- 4
840124	153509	4	37	39	29	29	6	7	2	- 4
840124	163508	4	31	34	26	25	5	4	1	- 5
840124	171615	4	27	30	22	22	2	2	- 2	- 7
840124	181445	4	22	26	19	19	0	1	- 4	- 8
840124	191105	4	19	22	16	15	- 2	- 2	- 6	-10
840124	201301	4	15	18	12	12	- 3	- 3	- 8	-11
840124	214832	4	11	13	8	7	- 5	- 5	-11	-13
840124	225132	4	7	9	4	4	- 7	- 7	-13	-15
840125	002732	4	4	5	1	1	- 8	- 8	-14	-15
840125	021332	4	0	1	- 2	- 2	-10	- 9	-15	-16
840125	044132	4	- 3	- 3	- 5	- 6	-12	-12	-17	-18
840125	072332	4	- 7	- 7	- 9	- 9	-14	-14	-18	-18
840125	090602	4	- 9	- 2	-11	-11	-15	-15	-19	-18
840125	090631	4	- 9	- 9	-11	-11	-16	-15	- 1	-18
840125	091601	4	- 9	- 9	-11	-11	-15	-14	-18	-18
840125	093334	4	- 9 ***	-11	-11	-15	-15	-19	-17	
840125	093421	4	- 9 ***	-11	-11	-15	-15	-19	-17	
840125	093607	4	- 9	- 9	-11	-11	-15	-15	- 0	-17
840125	093703	4	- 9 ***	-11	-11	-16	-15	-19	-18	
840125	093755	4	- 9	- 1	-11	-11	-15	-15	-19	-17
840125	095947	4	- 9	- 9	-11	-11	-15	-15	-18	-17
840125	101129	4	-10 ***	-12	-12	-16	-15	-19	-17	
840125	101212	4	-10	-10	-11	-12	-16	-15	93	-17
840125	101258	4	-10	-10	-11	-12	-16	-15	-18	-17

UNCLASSIFIED

UNCLASSIFIED

/ D-8

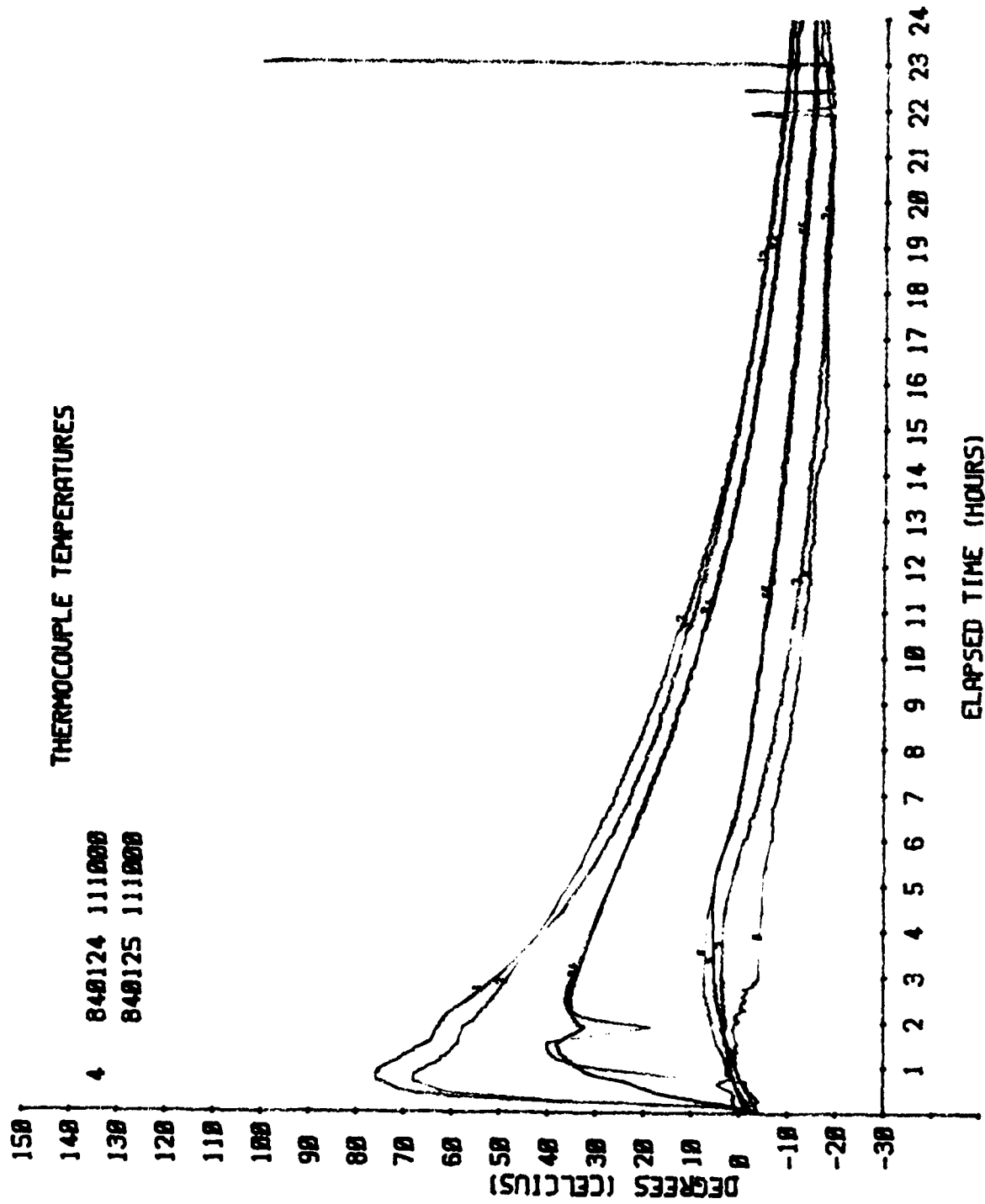


FIGURE D-1

UNCLASSIFIED

UNCLASSIFIED

/D-9

TABLE D-2

THERMOCOUPLE TEMPERATURES

DATE	TIME	VEH	1	2	3	4	5	6	7	8
840125	105236	4	-10	-10	-12	-11	-15	-15	-17	-16
840125	121347	4	-11	-12	-13	-13	-12	-11	-14	-14
840125	130747	4	-11	-12	-12	-12	-8	-7	-9	-11
840125	131237	4	-12	-12	-12	-12	-8	-2	-11	-10
840125	131537	4	-12	-11	-11	-12	-7	3	-11	-10
840125	131737	4	-11	-11	-11	-13	-7	0	-11	-12
840125	140158	4	48	43	5	-12	-1	0	-12	-12
840125	140258	4	54	50	6	-12	-2	0	-12	-13
840125	140358	4	60	57	7	-12	-2	0	-12	-13
840125	140458	4	66	64	9	-11	-2	0	-12	-13
840125	140613	4	72	72	11	-11	-2	0	-12	-13
840125	140913	4	74	75	12	-7	-2	1	-12	-13
840125	141113	4	73	73	14	-2	-2	-1	-10	-12
840125	141313	4	73	72	16	-2	-2	-1	-9	-12
840125	141513	4	73	71	18	-7	-2	-1	-9	-13
840125	141813	4	72	69	19	-12	-2	-2	-8	-13
840125	142113	4	71	68	21	-17	-2	-1	-8	-13
840125	142541	4	70	65	22	-21	-3	-2	-8	-13
840125	143423	4	67	61	25	-26	-3	-2	-9	-13
840125	144607	4	62	57	28	-28	-3	-2	-8	-13
840125	145250	4	58	54	29	-28	-3	-3	-8	-13
840125	151331	4	54	51	30	-28	-3	-3	-8	-13
840125	152625	4	50	48	29	-28	-3	-4	-8	-15
840125	154443	4	46	45	29	-27	-4	-4	-8	-15
840125	160236	4	42	42	27	-25	-4	-4	-9	-15
840125	162441	4	38	39	26	-24	-4	-4	-9	-15
840125	165028	4	33	36	24	-22	-5	-5	-9	-16
840125	174144	4	27	30	21	-19	-5	-5	-10	-16
840125	182103	4	22	26	17	-16	-6	-6	-11	-15
840125	185700	4	18	23	14	-13	-9	-10	-12	-16
840125	190250	4	18	22	14	-13	***	***	-12	-16
840125	190300	4	18	22	14	-13	***	***	-12	-16
840125	190310	4	18	22	14	-13	***	***	-12	-16
840125	190410	4	18	22	14	-13	***	***	-11	-16
840125	190420	4	18	22	14	-13	***	***	-11	-16
840125	202514	4	12	16	9	-8	-4	***	-12	-16
840125	212612	4	9	12	6	-6	0	***	-13	-15
840125	223926	4	5	8	3	-3	-3	***	-14	-14
840126	001326	4	2	4	0	-0	-5	***	-13	-13
840126	022626	4	-2	-1	-3	-3	-7	***	-12	-13
840126	060526	4	-5	-5	-6	-7	-10	***	-13	-13
840126	104155	4	-7	-7	-8	-8	-9	-8	-8	-7

UNCLASSIFIED

UNCLASSIFIED

/D-10

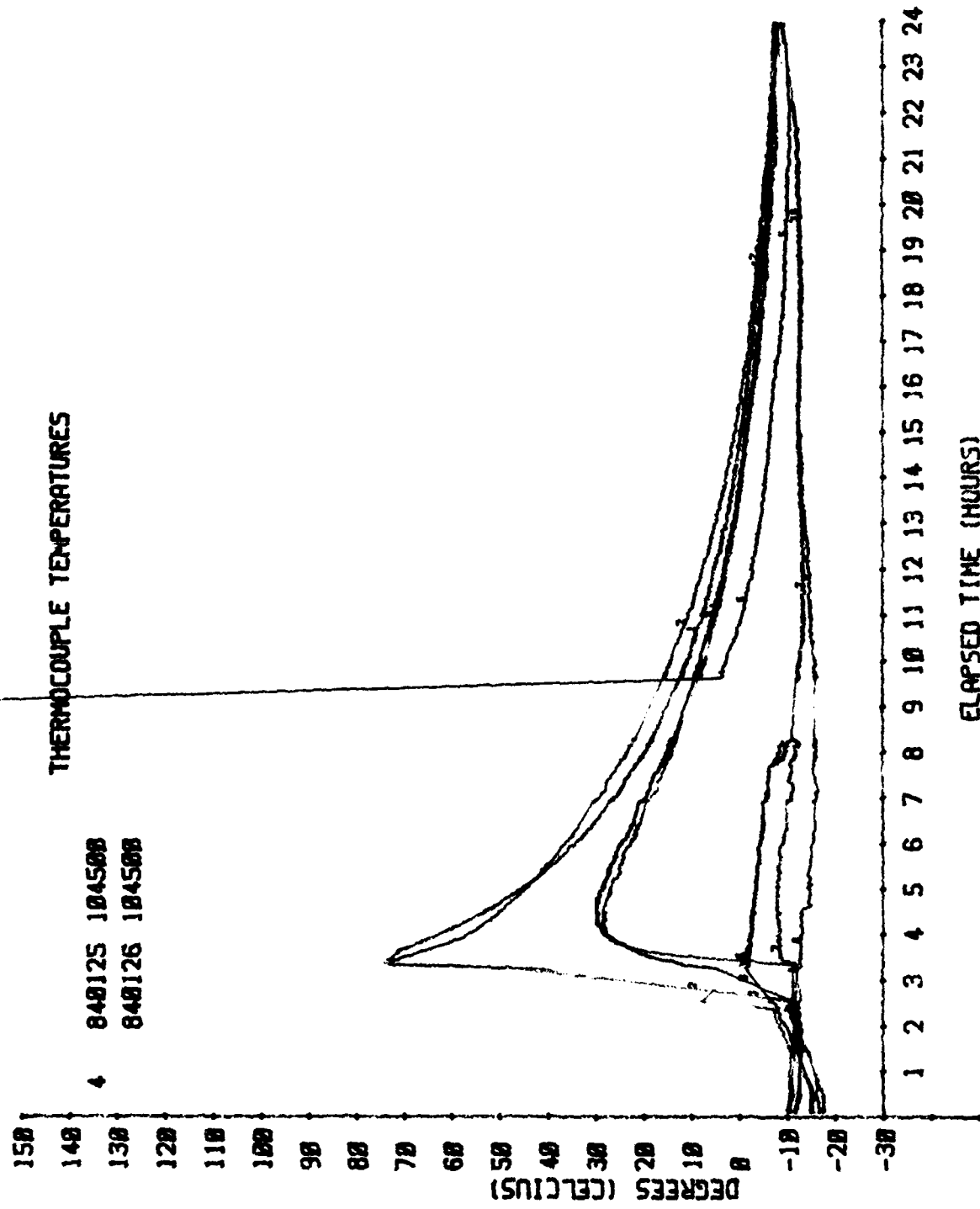


FIGURE D-2

UNCLASSIFIED

UNCLASSIFIED

/D-11

TABLE D-3

DATE	TIME	VEH	THERMOCOUPLE TEMPERATURES							
			1	2	3	4	5	6	7	8
840126	101655	4	-7	-7	-8	-8	-10	***	-10	-8
840126	104155	4	-7	-7	-8	-8	-9	-8	-8	-7
840126	105455	4	2	2	6	10	9	9	9	6
840126	110307	4	38	29	-1	-11	-8	-8	-9	-8
840126	110507	4	43	33	-0	-11	-8	-9	-10	-9
840126	193712	4	12	16	8	8	10	11	15	10
840126	202939	4	9	12	5	5	-12	-12	-17	-20
840126	110658	4	46	36	1	-11	-8	-8	-9	-8
840126	111436	4	60	48	7	-10	-8	-8	-9	-9
840126	111736	4	64	54	9	-9	-8	-8	-9	-8
840126	112940	4	98	82	33	-4	-8	-8	-9	-9
840126	113140	4	***	87	36	-1	-8	-8	-8	-9
840126	113340	4	***	88	37	6	-8	-8	-8	-9
840126	113540	4	***	88	38	15	-8	-8	-7	-10
840126	113740	4	***	98	40	21	-8	-8	-7	-10
840126	113940	4	***	97	41	28	-8	-8	-8	-10
840126	114140	4	***	87	42	32	-8	-8	-7	-10
840126	114340	4	***	86	43	36	-8	-8	-7	-10
840126	114640	4	98	85	45	41	-8	-8	-7	-9
840126	115040	4	97	84	47	45	-8	-8	-6	-10
840126	115240	4	94	82	49	49	-8	-8	-7	-10
840126	120716	4	89	79	49	51	-8	-8	-7	-10
840126	121816	4	85	77	51	51	-7	-8	-7	-12
840126	122916	4	80	74	50	50	-8	-8	-6	-11
840126	124116	4	76	71	49	48	-7	-7	-6	-11
840126	125310	4	72	68	48	47	-7	-7	-6	-11
840126	131451	4	65	64	45	44	-7	-6	-6	-9
840126	132756	4	61	61	43	42	-7	-6	-6	-11
840126	134325	4	57	59	41	40	-7	-6	-6	-11
840126	203645	4	8	11	5	5	-11	-13	-17	-19
840126	225512	4	4	6	1	1	-13	-14	-18	-21
840126	161054	4	31	37	25	25	-6	-6	-9	-15
840126	163820	4	27	33	22	21	-8	-7	-10	-17
840126	171520	4	23	29	19	18	-8	-8	-12	-17
840126	175420	4	20	25	16	15	-9	-9	-14	-18
840126	183926	4	16	21	12	11	-10	-11	-14	-18
840126	220016	4	4	6	1	1	-13	-14	-18	-21
840126	231024	4	1	2	-2	-2	-14	-15	-20	-23
840127	004705	4	3	2	5	6	-16	-17	-21	-23
840127	025105	4	-6	-6	-9	-9	-17	-18	-21	-23
840127	054805	4	-10	-10	-12	-12	-18	-18	-21	-21
840127	084344	4	-13	-13	-13	***	-18	-19	-19	-18
840127	084429	4	-12	-13	-14	-0	-18	-18	-19	-18
840127	084707	4	-13	-13	-14	***	-18	-18	-19	-18
840127	084807	4	-12	-13	-14	***	-18	-19	-19	-18
840127	085007	4	-12	-13	-14	***	-18	-18	-19	-18
840127	085221	4	-13	-13	-14	***	-19	-19	-19	-19
840127	085303	4	-13	-13	-14	***	-18	-18	-19	-18
840127	085415	4	-13	-13	-14	***	-19	-18	-19	-18
840127	085502	4	-13	-13	-14	***	-19	-18	-19	-18
840127	085834	4	-13	-13	-14	***	-19	-18	-19	-18
840127	085909	4	-13	-13	-13	***	-19	-18	-19	-18
840127	085948	4	-13	-13	-14	***	-19	-19	-19	-18
840127	090035	4	-13	-13	-14	98	-18	-18	-19	-18
840127	090108	4	-13	-13	-14	***	-19	-19	-19	-18
840127	090308	4	-13	-13	-14	-15	-19	-19	-19	-18

UNCLASSIFIED

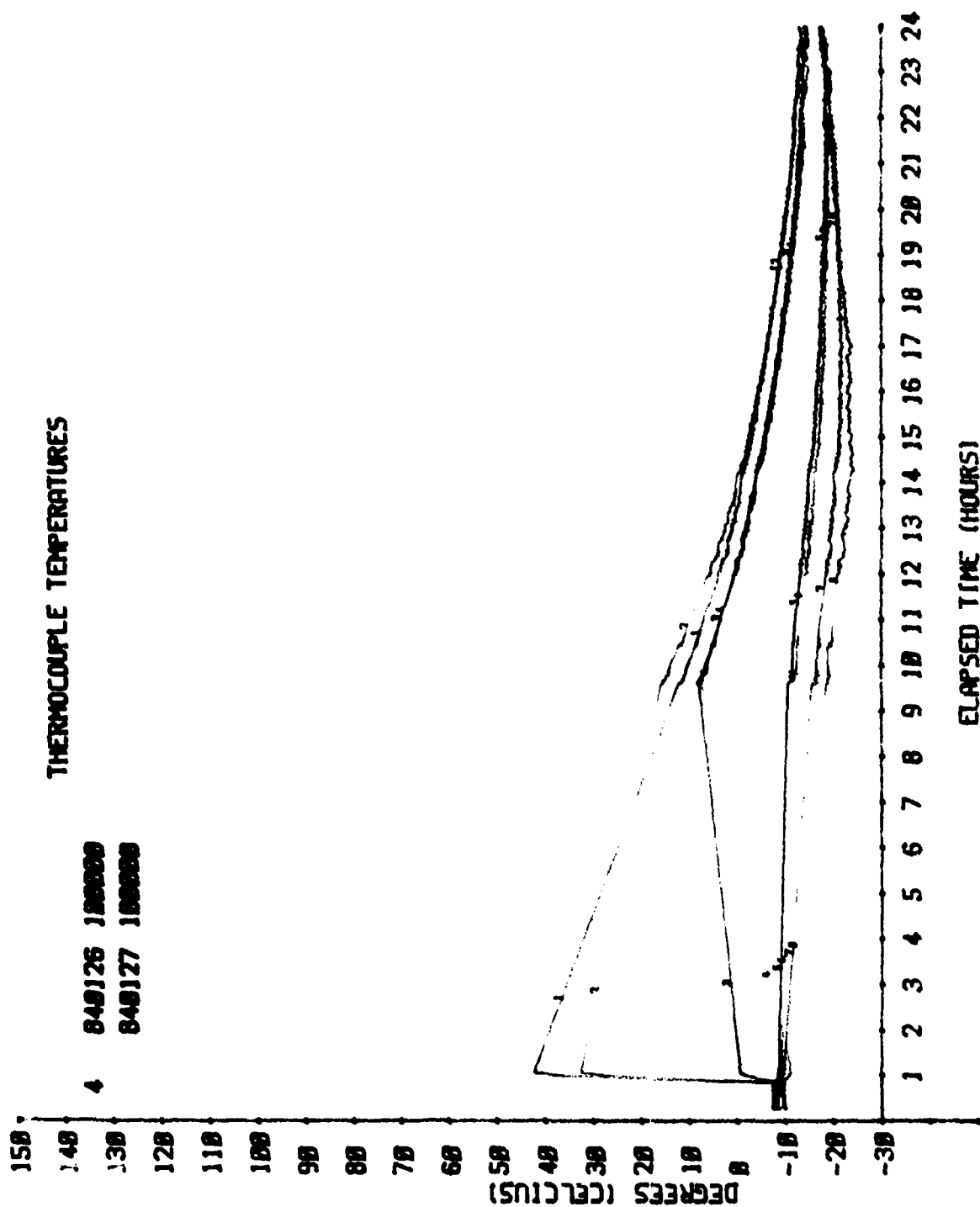


FIGURE D-3

UNCLASSIFIED

/D-13

TABLE D-4

DATE	TIME	VEH	THERMOCOUPLE TEMPERATURES							
			1	2	3	4	5	6	7	8
840127	095156	4	-13	-13	-15	-14	-17	-17	-17	-17
840127	102341	4	-13	-14	-3	-15	-16	-17	-17	-17
840127	102441	4	-13	-13	-14	-15	-15	-16	-17	-16
840127	102511	4	-13	-13	23	-15	-15	-16	-18	-17
840127	102611	4	-13	-13	36	-15	-15	-16	-17	-16
840127	102711	4	-13	-13	47	-15	-15	-16	-17	-16
840127	102811	4	-13	-13	57	-14	-15	-16	-18	-16
840127	102911	4	-13	-13	63	-14	-15	-16	-17	-16
840127	103111	4	-13	-13	70	-14	-15	-16	-17	-16
840127	103221	4	-13	-13	59	-14	-15	-16	-17	-16
840127	103321	4	-14	-13	31	-14	-15	-16	-18	-16
840127	103421	4	-16	-11	-6	-15	-15	-16	-18	-16
840127	103521	4	-2	-6	-8	-17	-15	-16	-17	-17
840127	103821	4	4	-1	-11	-17	-14	-15	-18	-16
840127	103921	4	14	4	-9	-17	-14	-16	-17	-16
840127	104021	4	21	9	-9	-17	-15	-16	-18	-16
840127	104822	4	***	***	***	***	***	***	***	***
840127	104852	4	***	***	***	***	***	***	***	***
840127	104952	4	***	***	***	***	***	***	***	***
840127	105052	4	***	***	***	***	***	***	***	***
840127	105152	4	56	45	-5	-16	-14	-16	-17	-16
840127	105252	4	60	52	-3	-15	-14	-15	-17	-16
840127	105352	4	64	58	-3	-16	-14	-15	-17	-16
840127	105439	4	68	63	-2	-15	-14	-16	-17	-16
840127	114549	4	59	53	28	24	-13	-14	-15	-16
840127	115749	4	55	50	28	24	-14	-14	-15	-15
840127	121158	4	51	48	28	23	-14	-14	-14	-15
840127	122626	4	47	45	27	23	-13	-13	-14	-15
840127	124335	4	42	42	26	22	-13	-13	-13	-15
840127	130151	4	38	39	24	20	-13	-13	-13	-15
840127	153055	4	18	21	14	10	-13	-13	-13	-14
840127	161311	4	15	17	12	7	-13	-13	-13	-14
840127	165023	4	12	14	8	6	-13	-13	-13	-14
840127	174625	4	8	10	6	3	-14	-13	-13	-14
840127	181625	4	7	8	5	2	***	-12	-12	-13
840127	184650	4	6	7	3	1	9	-11	-13	-13
840127	184919	4	6	7	3	0	10	-2	-13	-13
840127	190923	4	5	6	2	1	12	2	-12	-12
840127	205404	4	1	2	1	1	9	2	-12	-12
840127	225108	4	-1	-1	-3	-4	5	-0	-11	-10
840128	003006	4	-3	***	-4	-4	2	-2	-11	-11
840128	003106	4	-3	-3	-4	-4	2	-2	-11	-11
840128	031341	4	-5	-5	-6	-6	-2	-5	-12	-13
840128	080251	4	-8	-8	-9	-8	-6	-8	-12	-12

UNCLASSIFIED

UNCLASSIFIED

/ D-14

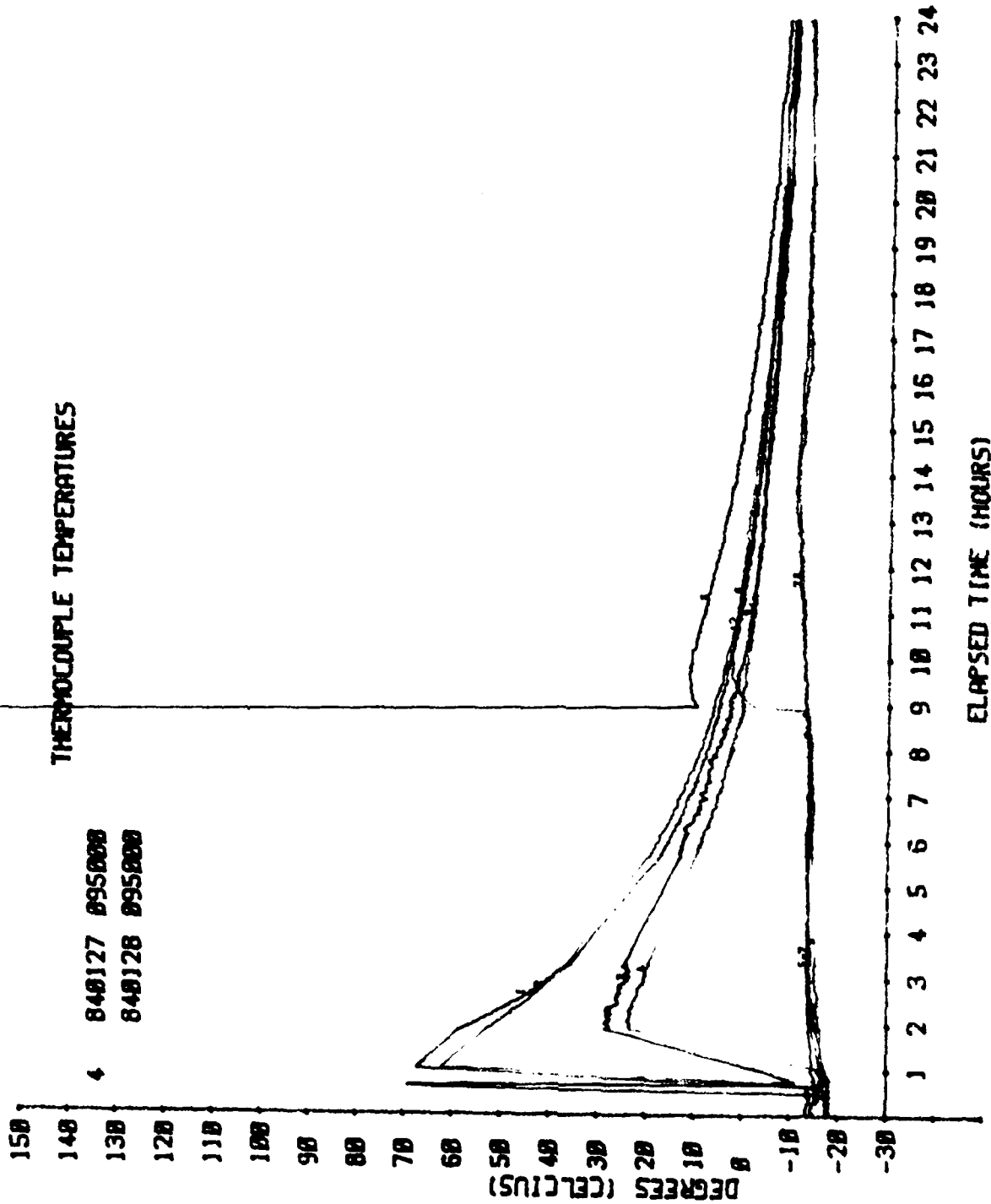


FIGURE D-4

UNCLASSIFIED

UNCLASSIFIED

/D-15

TABLE D-5

			THERMOCOUPLE TEMPERATURES							
DATE	TIME	VEH	1	2	3	4	5	6	7	8
840128	095012	4	-8	-9	-9	-9	-8	-9	-12	-12
840128	100029	4	-0	-3	-9	-11	-5	-8	-12	-11
840128	100129	4	11	1	-8	-12	-4	-8	-13	-11
840128	100229	4	18	6	-8	-12	-5	-9	-12	-12
840128	100429	4	24	12	-7	-12	-5	-8	-12	-11
840128	100529	4	30	16	-6	-12	-5	-8	-12	-11
840128	100629	4	32	20	-6	-12	-5	-8	-12	-11
840128	100829	4	37	26	-5	-12	-5	-9	-13	-12
840128	101029	4	42	31	-4	-12	-5	-8	-12	-11
840128	101229	4	46	36	-3	-11	-5	-8	-12	-11
840128	101624	4	49	40	-2	-11	-5	-8	-12	-11
840128	101921	4	53	43	-1	-11	-5	-8	-12	-11
840128	102421	4	57	48	0	-11	-5	-8	-12	-11
840128	102921	4	61	52	1	-10	-5	-8	-12	-11
840128	103611	4	65	57	4	-10	-5	-8	-12	-11
840128	104431	4	69	61	6	-10	-5	-7	-12	-11
840128	105450	4	73	66	8	-10	-5	-7	-11	-10
840128	110150	4	74	67	12	-5	-5	-7	-11	-10
840128	110350	4	74	67	15	0	-5	-7	-11	-10
840128	110550	4	74	67	18	7	-5	-7	-11	-10
840128	110750	4	75	64	20	12	-5	-7	-10	-10
840128	110950	4	74	66	21	16	-5	-7	-10	-10
840128	111217	4	74	65	24	20	-5	-7	-9	-9
840128	111612	4	73	63	25	25	-5	-7	-9	-10
840128	112128	4	72	62	27	29	-5	-7	-9	-9
840128	113417	4	67	59	31	32	-5	-7	-9	-9
840128	114245	4	63	54	32	34	-5	-7	-8	-9
840128	120335	4	59	54	33	33	-5	-6	-7	-8
840128	121755	4	55	51	33	32	-5	-6	-7	-9
840128	123527	4	50	49	32	31	-5	-6	-8	-8
840128	125253	4	46	46	31	31	-5	-6	-6	-8
840128	131457	4	42	43	30	29	-5	-5	-5	-8
840128	133810	4	38	40	28	27	-5	-6	-5	-8
840128	140710	4	34	37	26	25	-5	-6	-7	-7
840128	145911	4	28	32	23	22	-5	-5	-5	-7
840128	153758	4	24	28	20	19	-6	-6	-7	-9
840128	163229	4	20	24	17	17	-5	-5	-5	-10
840128	173524	4	16	20	14	14	-6	-6	-7	-13
840128	181726	4	14	17	12	10	-6	-7	-8	-14
840128	192439	4	11	13	8	8	-7	-8	-9	-15
840128	204818	4	7	9	5	4	-8	-11	-12	-18
840128	225657	4	3	4	1	0	***	-11	-13	-15
840128	225726	4	3	4	0	0	***	-12	-13	-15
840128	225844	4	3	4	1	0	***	-12	-13	-15
840128	225953	4	3	4	1	0	***	-12	-13	-15
840128	230049	4	3	4	1	0	***	-12	-13	-15
840128	230252	4	3	4	1	0	***	-12	-13	-15
840128	230419	4	2	4	0	0	***	-12	-13	-15
840128	231310	4	2	3	0	0	***	-12	-14	-16
840128	231500	4	2	3	0	0	0	-12	-13	-16
840128	231738	4	2	4	0	0	-10	-12	-13	-15
840129	011438	4	-1	-1	-3	-3	-12	-13	-14	-16
840129	043438	4	-5	-5	-6	-7	-12	-13	-13	-13

UNCLASSIFIED

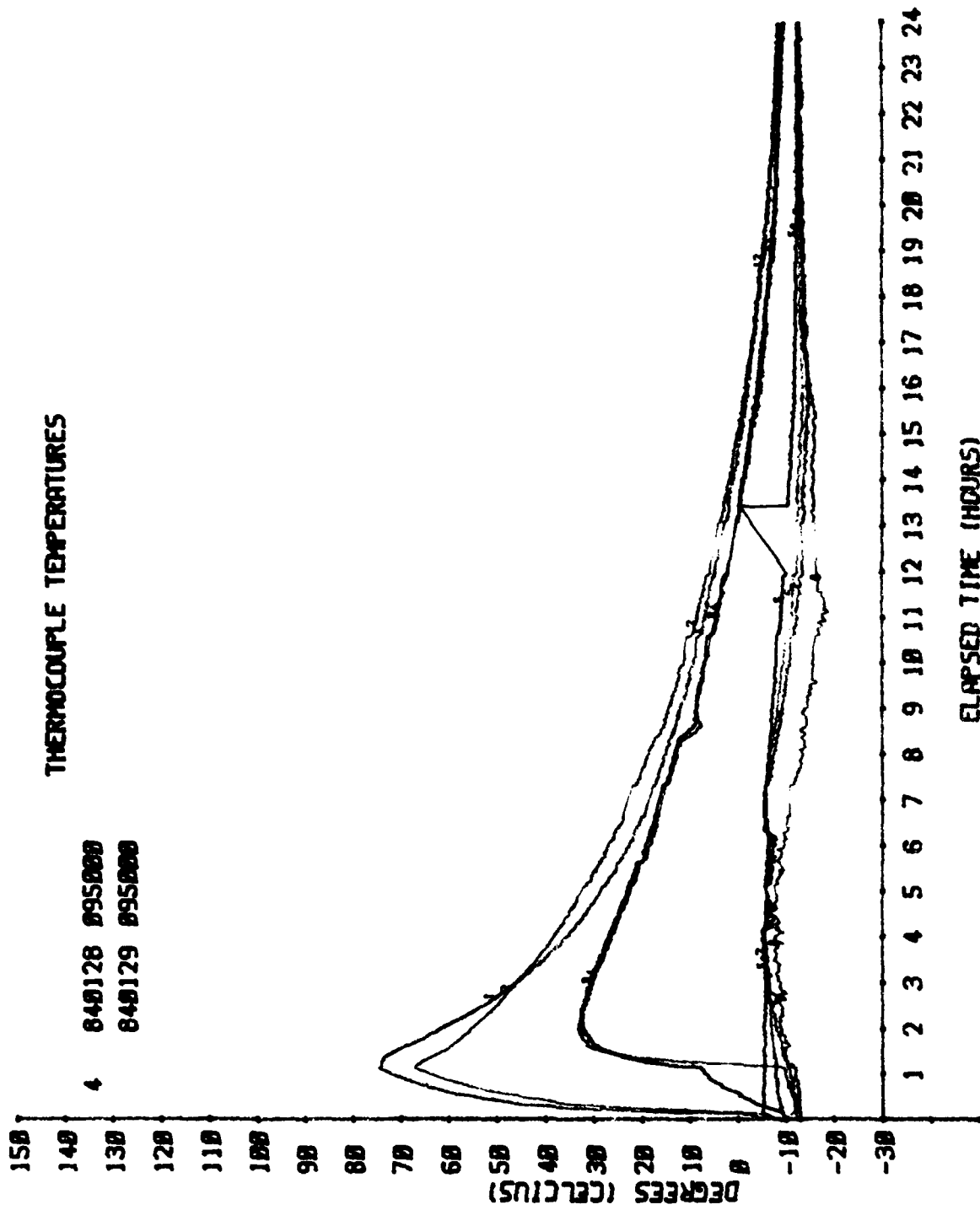


FIGURE D-5

UNCLASSIFIED

TABLE D-6

/D-17

DATE	TIME	VEH	THERMOCOUPLE TEMPERATURES							
			1	2	3	4	5	6	7	8
840129	100020	4	-	8	-	8	-	9	-	9
840129	101914	4	1	-	2	-	8	-	10	-
840129	101944	4	6	-	0	-	8	-	11	-
840129	102044	4	13	4	-	7	-	12	-	9
840129	102144	4	17	8	-	7	-	11	-	9
840129	102344	4	23	14	-	6	-	11	-	9
840129	103244	4	27	17	-	6	-	11	-	9
840129	103344	4	32	20	-	5	-	11	-	9
840129	103544	4	37	24	-	3	-	11	-	9
840129	103744	4	41	30	-	2	-	11	-	9
840129	103944	4	45	35	-	1	-	11	-	9
840129	104244	4	49	40	-	1	-	11	-	8
840129	104544	4	53	45	2	-	10	-	9	-
840129	104844	4	56	49	4	-	10	-	9	-
840129	105144	4	60	53	6	-	10	-	9	-
840129	105544	4	64	58	8	-	10	-	9	-
840129	110007	4	69	62	10	-	9	-	8	-
840129	110507	4	72	67	13	-	9	-	9	-
840129	111010	4	76	71	15	-	9	-	9	-
840129	112816	4	86	81	29	-	6	-	8	-
840129	113016	4	90	86	32	-	6	-	9	-
840129	113216	4	94	90	34	-	6	-	8	-
840129	113516	4	***	97	37	-	6	-	8	-
840129	113716	4	***	***	40	-	5	-	9	-
840129	113916	4	***	***	42	2	-	9	-	9
840129	114116	4	***	***	45	10	-	9	-	10
840129	114316	4	***	***	46	18	-	9	-	9
840129	114522	4	***	***	47	25	-	8	-	9
840129	114722	4	***	***	48	31	-	8	-	9
840129	114911	4	***	98	49	35	-	8	-	9
840129	115211	4	***	96	51	41	-	8	-	9
840129	115611	4	***	94	51	46	-	8	-	9
840129	120209	4	97	91	53	50	-	8	-	9
840129	121157	4	92	87	54	52	-	8	-	9
840129	122157	4	88	83	54	53	-	8	-	8
840129	123157	4	84	80	54	52	-	8	-	9
840129	124257	4	80	77	53	51	-	8	-	9
840129	125457	4	75	74	52	50	-	8	-	8
840129	130657	4	71	71	51	49	-	8	-	8
840129	131957	4	67	68	49	47	-	8	-	8
840129	133457	4	63	66	48	46	-	8	-	8
840129	135157	4	59	62	46	45	-	8	-	8
840129	141057	4	55	60	44	42	-	8	-	8
840129	142857	4	51	57	42	40	-	8	-	8
840129	145354	4	47	54	40	39	-	8	-	8
840129	151654	4	42	50	37	35	-	8	-	8
840129	154507	4	38	46	34	33	-	7	-	7
840129	154907	4	***	46	34	33	-	8	***	-
840129	155226	4	***	45	33	33	-	8	***	-
840129	155330	4	***	45	33	32	-	8	***	-
840129	155437	4	***	45	33	33	-	7	***	-
840129	155557	4	***	45	33	32	-	7	***	-
840129	155704	4	***	45	33	32	-	7	***	-
840129	155758	4	***	45	33	32	-	7	***	-
840129	155847	4	***	45	33	32	-	8	***	-
840129	155959	4	***	45	33	32	-	8	***	-
840129	160100	4	***	44	32	32	-	8	***	-
840129	160215	4	***	44	32	32	-	8	***	-
840129	160341	4	***	44	32	32	-	8	***	-

UNCLASSIFIED

UNCLASSIFIED

/D-18

TABLE D-6 (Cont'd)

840129 160534	4	***	44	32	32	- 8	***	- 5	-10
840129 160712	4	***	44	32	32	- 8	***	- 5	-10
840129 160820	4	- 0	44	32	31	- 8	***	- 5	-10
840129 160951	4	***	44	32	31	- 7	0	- 5	-10
840129 161057	4	***	44	32	31	- 8	***	- 5	-10
840129 161211	4	***	43	32	31	- 7	***	- 5	-10
840129 162020	4	***	43	31	31	- 7	***	- 5	-10
840129 162323	4	***	42	31	30	- 8	***	- 5	-11
840129 162451	4	***	41	31	30	- 7	***	- 5	-11
840129 162556	4	***	42	31	30	- 7	***	- 5	-11
840129 162659	4	***	41	30	30	- 7	***	- 5	-11
840129 162755	4	***	41	30	30	- 7	***	- 5	-11
840129 162853	4	***	41	30	29	- 8	***	- 5	-11
840129 162953	4	***	41	30	29	- 8	***	- 5	-11
840129 163049	4	***	41	30	29	- 8	***	- 5	-11
840129 163249	4	***	41	30	29	- 7	***	- 5	-11
840129 163351	4	***	40	30	29	- 8	***	- 5	-11
840129 163443	4	***	40	30	29	- 7	***	- 5	-10
840129 163715	4	32	40	29	29	- 8	- 7	- 5	-11
840129 171225	4	29	36	27	26	- 8	- 7	- 6	-12
840129 175225	4	25	32	23	22	- 8	- 8	- 7	-12
840129 183727	4	22	28	20	19	- 8	- 9	- 8	-13
840129 192835	4	18	24	16	15	- 8	- 9	- 8	-13
840129 204510	4	15	19	12	11	- 8	-10	-10	-13
840129 223337	4	9	12	7	6	- 9	-10	-11	-14
840129 233908	4	6	8	4	3	-10	-12	-12	-18
840130 010759	4	2	5	0	0	-12	-14	-14	-18
840130 024759	4	- 1	0	- 3	- 3	-13	-15	-16	-21
840130 045659	4	- 4	- 4	- 7	- 7	-15	-17	-19	-25
840130 071659	4	- 8	- 8	-10	-10	-16	-19	-21	-23
840130 085837	4	- 9	-10	-12	-14	-17	-19	-18	-18

UNCLASSIFIED

UNCLASSIFIED

/D-19

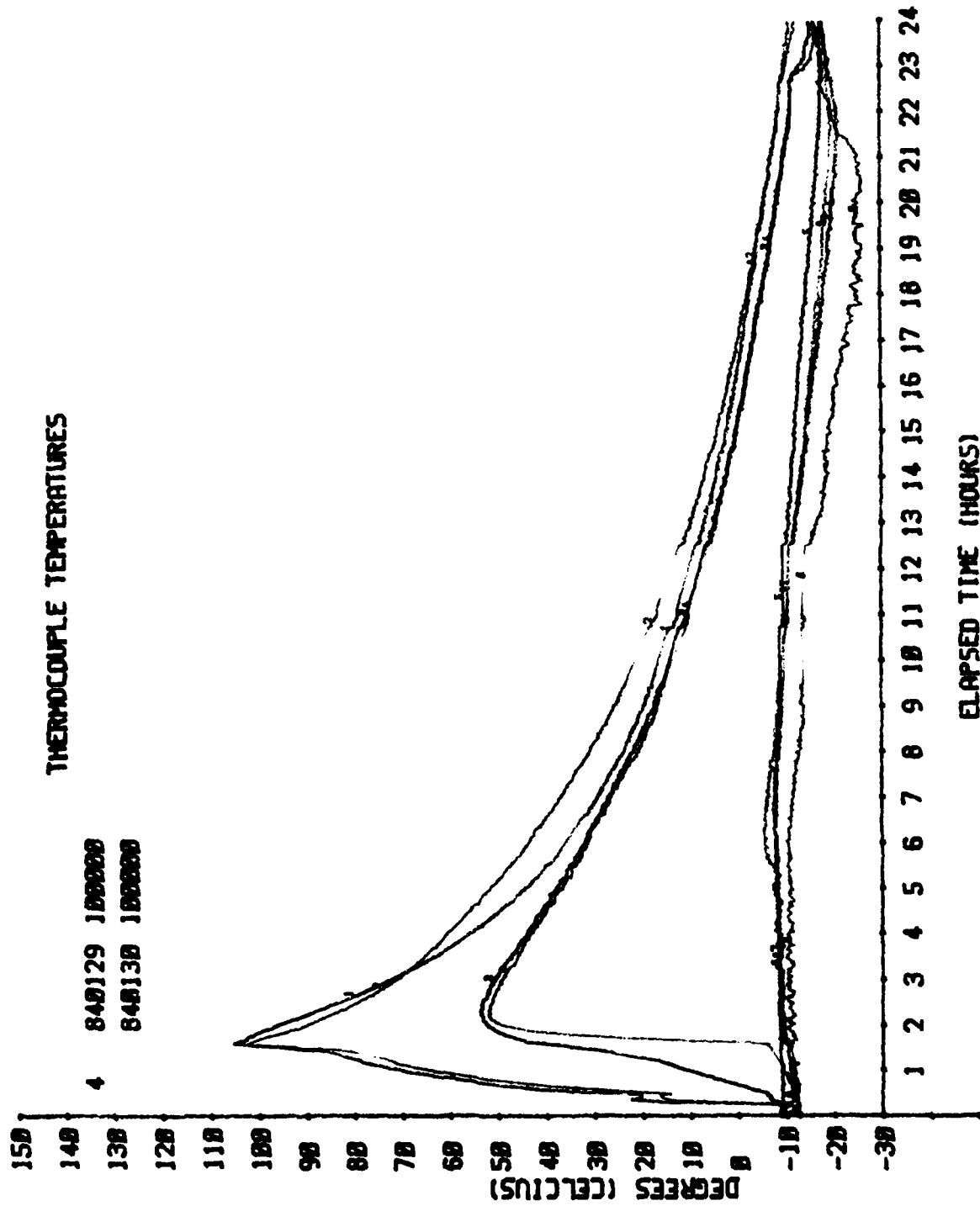


FIGURE D-6

UNCLASSIFIED

UNCLASSIFIED

TABLE D-7

/D-20

			THERMOCOUPLE TEMPERATURES							
DATE	TIME	VEH	1	2	3	4	5	6	7	8
840130	125055	4	-13	-13	-13	-13	-15	-13	-13	-11
840130	143759	4	-13	-11	-11	-12	-10	-11	-11	-9
840130	154819	4	12	11	1	11	9	9	9	6
840130	154919	4	-12	-11	10	-10	-9	-9	-9	-8
840130	155040	4	-12	-11	22	-10	-9	-9	-9	-8
840130	155140	4	-8	-10	-4	-10	-7	-9	-9	-7
840130	155240	4	1	-4	-4	-11	-9	-9	-9	-8
840130	155340	4	10	0	-4	-12	-9	-9	-10	-9
840130	155540	4	17	-6	-3	-12	-8	-8	-9	-8
840130	155640	4	25	14	-3	-13	-9	-9	-10	-9
840130	155740	4	34	23	-2	-13	-8	-9	-9	-9
840130	155840	4	40	28	-0	-12	-8	-9	-9	-9
840130	160040	4	45	33	1	-12	-8	-9	-9	-9
840130	160240	4	51	39	2	-12	-9	-9	-9	-9
840130	160920	4	61	49	7	-11	-8	-9	-9	-9
840130	161219	4	64	54	9	-11	-9	-9	-9	-9
840130	161519	4	69	59	11	-10	-8	-9	-9	-8
840130	161819	4	75	65	12	-10	-8	-9	-9	-9
840130	162019	4	79	69	13	-10	-8	-9	-9	-8
840130	162219	4	83	74	15	-9	-9	-9	-9	-9
840130	162419	4	88	74	17	-9	-9	-9	-9	-9
840130	162619	4	92	80	20	-8	-9	-9	-9	-8
840130	162819	4	96	85	22	-8	-8	-8	-8	-9
840130	163019	4	96	85	25	-2	-8	-8	-4	-8
840130	163219	4	96	85	28	4	-8	-8	-1	-9
840130	163419	4	96	84	31	11	-8	-7	1	-9
840130	163621	4	96	83	32	17	-8	-6	1	-9
840130	163821	4	95	83	34	22	-7	-6	2	-8
840130	164121	4	94	82	36	27	-7	-5	2	-9
840130	164521	4	92	80	38	32	-7	-4	3	-8
840130	165354	4	88	77	40	36	-7	-4	3	-8
840130	170254	4	84	74	41	37	-6	-3	4	-9
840130	171054	4	80	70	40	36	-6	-3	3	-9
840130	172025	4	75	67	40	36	-6	-3	4	-8
840130	172925	4	71	65	40	35	-6	-3	3	-9
840130	174125	4	67	62	38	33	-6	-3	3	-9
840130	175225	4	62	59	36	32	-6	-3	3	-9
840130	180525	4	58	57	34	30	-6	-3	3	-9
840130	182037	4	54	53	32	28	-6	-3	1	-8
840130	183437	4	50	49	29	25	-6	-3	0	-8
840130	183737	4	49	45	24	16	-6	-3	1	-8
840130	183837	4	49	44	14	13	-6	-3	1	-9
840130	184037	4	49	47	20	14	-6	-3	1	-9
840130	184537	4	49	47	24	18	-6	-3	1	-9
840130	185637	4	49	45	25	22	-6	-3	1	-9
840130	191716	4	47	42	24	21	-6	-5	-3	-8
840130	193416	4	42	39	23	18	-6	-5	-3	-8
840130	195416	4	38	36	21	18	-6	-5	-2	-8
840130	201522	4	34	32	20	17	-6	-5	-2	-9
840130	204011	4	30	30	17	15	-4	-4	-2	-9
840130	204611	4	29	29	17	14	-5	-7	-4	-9
840130	211430	4	25	25	15	11	-8	-8	-6	-10
840130	222321	4	18	19	10	7	-5	-8	-7	-11
840130	223321	4	17	17	9	6	-4	-4	-7	-12
840130	232021	4	13	14	6	5	-3	-4	-7	-12
840131	001521	4	9	10	4	2	-1	-6	-8	-13
840131	013621	4	5	6	1	1	-1	-6	-7	-9
840131	032521	4	1	1	-1	-3	-3	-7	-9	-10
840131	060521	4	-2	-3	-5	-6	-6	-10	-12	-15

UNCLASSIFIED

UNCLASSIFIED

/D-21

TABLE D-7 (Cont'd)

840131	093329	4	-	6	-	7	-	8	-	9	-	9	-11	-13	-12
840131	112337	4	-	8	-	8	-	8	-	9	-	9	-	9	5

UNCLASSIFIED

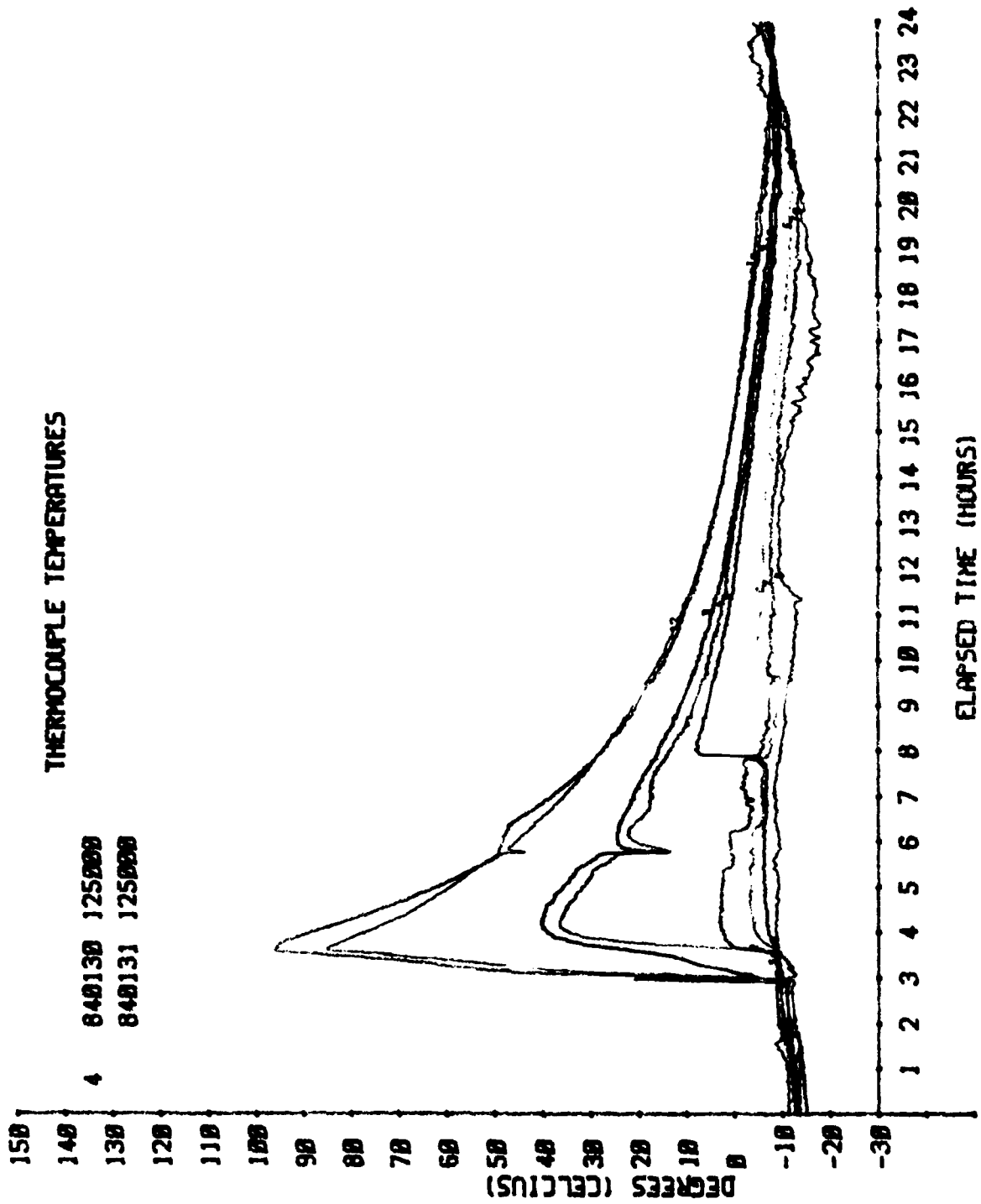


FIGURE D-7

UNCLASSIFIED

/ D-23

TABLE D-8

DATE	TIME	VEH	THERMOCOUPLE TEMPERATURES							
			1	2	3	4	5	6	7	8
840131	095029	4	- 6	- 7	- 8	- 9	- 9	-11	-12	-12
840131	113837	4	- 8	- 8	- 8	- 9	- 8	- 8	- 8	- 6
840131	130031	4	1	- 2	- 4	- 9	- 5	- 4	- 5	- 1
840131	130131	4	7	1	- 3	- 9	- 5	- 4	- 5	- 2
840131	130231	4	13	6	- 3	- 9	- 4	- 4	- 5	- 2
840131	130331	4	25	13	- 1	- 9	- 4	- 4	- 5	- 2
840131	130531	4	31	19	- 0	- 9	- 4	- 4	- 5	- 3
840131	130731	4	35	23	1	- 9	- 4	- 4	- 4	- 2
840131	130931	4	42	31	3	- 8	- 4	- 3	- 5	- 2
840131	131031	4	46	34	4	- 9	- 4	- 3	- 5	- 2
840131	131231	4	53	40	5	- 8	- 4	- 4	- 5	- 3
840131	131431	4	57	45	7	- 8	- 4	- 3	- 4	- 3
840131	131831	4	57	46	9	- 3	- 4	- 2	- 2	- 2
840131	132131	4	56	45	11	2	- 4	- 3	- 3	- 2
840131	132431	4	56	45	12	6	- 4	- 2	- 2	- 3
840131	132831	4	56	44	14	10	- 4	- 2	- 3	- 3
840131	133631	4	54	42	16	15	- 4	- 2	- 3	- 3
840131	135731	4	49	38	19	17	- 3	- 1	- 2	- 2
840131	144234	4	38	32	19	18	- 2	3	3	- 1
840131	150134	4	34	30	19	17	- 2	3	3	- 3
840131	152734	4	30	27	18	16	- 1	3	3	- 3
840131	155734	4	26	24	16	14	- 1	3	3	- 4
840131	163916	4	22	21	14	12	- 1	2	2	- 4
840131	173316	4	17	17	11	10	- 1	- 1	0	- 3
840131	184203	4	13	13	8	7	- 2	- 3	- 2	- 5
840131	201422	4	10	9	5	4	- 3	- 3	- 3	- 1
840131	221722	4	6	6	3	2	- 2	- 3	- 2	- 1
840201	015934	4	2	1	- 0	- 0	- 3	- 4	- 4	- 5
840201	075734	4	- 2	- 2	- 4	- 4	- 5	- 7	- 7	- 7

UNCLASSIFIED

UNCLASSIFIED

/D-24

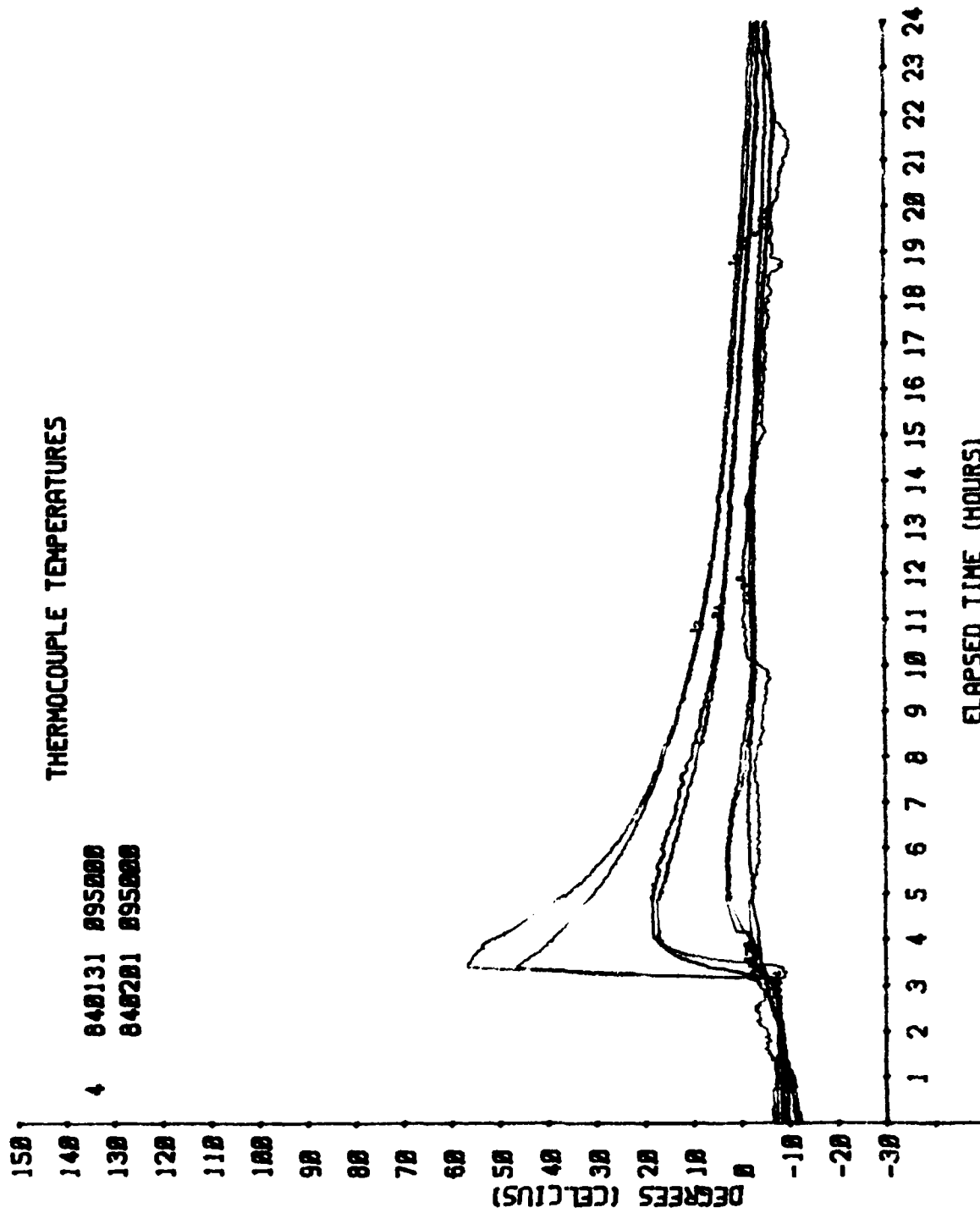


FIGURE D-8

UNCLASSIFIED

UNCLASSIFIED

TABLE D-9

/D-25

			THERMOCOUPLE TEMPERATURES							
DATE	TIME	VEH	1	2	3	4	5	6	7	8
840201	095059	4	3	3	4	4	5	5	5	3
840201	100117	4	6	2	3	6	4	5	4	3
840201	100325	4	18	11	1	5	4	5	4	2
840201	100425	4	30	18	0	5	4	5	4	2
840201	100525	4	34	22	0	6	4	5	4	2
840201	100625	4	38	26	1	5	4	5	4	2
840201	100725	4	43	30	3	5	4	4	5	2
840201	100925	4	47	35	4	5	4	5	4	2
840201	101325	4	50	40	6	5	4	4	4	2
840201	101725	4	54	44	8	4	3	4	3	3
840201	102053	4	58	48	9	4	4	4	3	3
840201	102253	4	63	53	12	4	3	4	3	2
840201	103013	4	66	57	17	5	3	3	1	2
840201	103213	4	66	56	18	9	3	2	1	2
840201	103513	4	66	55	19	14	3	2	1	2
840201	103939	4	65	54	21	18	3	2	2	1
840201	104644	4	64	52	23	22	3	1	3	1
840201	105858	4	60	49	24	24	3	1	3	2
840201	111255	4	55	47	25	24	3	0	3	1
840201	112755	4	51	44	25	24	3	0	4	1
840201	114355	4	47	42	25	23	2	0	4	1
840201	120055	4	43	39	24	22	2	1	4	1
840201	122055	4	39	36	22	21	2	1	4	1
840201	124355	4	35	34	22	20	1	1	4	1
840201	131255	4	31	30	20	18	1	1	4	1
840201	134755	4	26	27	18	16	1	1	4	2
840201	143537	4	22	23	15	14	1	1	4	2
840201	153028	4	18	19	13	13	0	1	3	2
840201	163924	4	15	***	11	10	1	0	***	3
840201	164126	4	15	***	11	10	0	1	***	3
840201	164224	4	15	***	11	10	0	0	***	2
840201	164324	4	15	***	11	10	0	1	***	2
840201	164427	4	15	***	11	10	1	0	***	3
840201	164513	4	15	***	11	10	0	0	***	2
840201	164648	4	14	***	10	10	0	0	***	3
840201	164746	4	14	***	10	9	1	0	***	3
840201	164829	4	14	***	10	10	1	0	***	3
840201	164947	4	14	***	11	10	0	0	***	3
840201	165341	4	14	***	10	10	0	0	***	3
840201	165430	4	14	2	10	10	0	0	***	3
840201	165515	4	14	***	10	9	0	0	2	3
840201	165700	4	14	***	10	9	0	0	***	3
840201	170000	4	14	***	10	9	1	0	***	3
840201	170100	4	14	***	10	9	1	0	***	3
840201	170200	4	14	***	10	9	0	0	***	3
840201	170300	4	14	***	10	9	0	0	***	3
840201	170422	4	14	***	10	9	1	0	***	3
840201	170739	4	14	***	10	9	1	0	***	3
840201	170822	4	14	***	10	9	0	0	***	3
840201	170926	4	13	***	10	9	1	0	***	3
840201	171028	4	13	***	10	9	1	0	***	3
840201	171323	4	13	96	10	9	0	0	***	3
840201	171418	4	13	***	9	8	1	0	96	3
840201	171507	4	13	***	9	9	1	0	70	3
840201	171607	4	13	***	9	9	1	0	47	3
840201	171707	4	13	14	10	9	1	0	1	3
840201	190100	4	7	10	7	6	1	1	0	2
840201	213807	4	6	6	4	3	1	2	1	2

UNCLASSIFIED

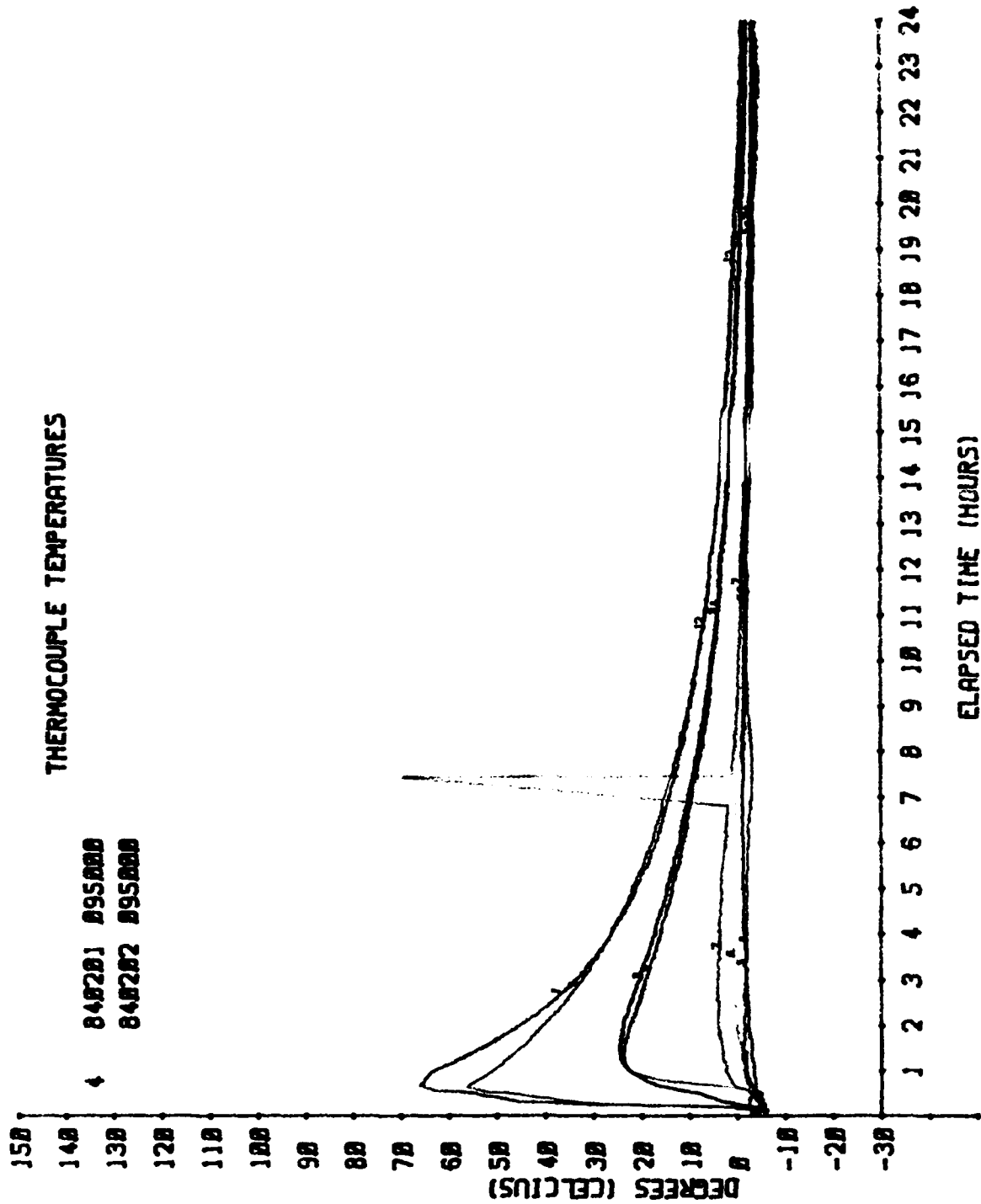


FIGURE D-9

UNCLASSIFIED

/D-27

TABLE D-10

			THERMOCOUPLE TEMPERATURES												
DATE	TIME	VEH	1	2	3	4	5	6	7	8					
840202	100051	4	-	1	-	2	-	2	-	3	-	3	-	4	
840202	170349	4	73	69	11	-	1	-	2	-	4	-	5	-	8
840202	171616	4	77	72	12	-	1	-	2	-	4	-	4	-	8
840202	174216	4	80	76	14	-	0	-	2	-	4	-	4	-	8
840202	181716	4	84	80	15	3	-	2	-	5	-	5	-	9	
840202	184220	4	85	82	16	7	-	3	-	5	-	4	-	10	
840202	191420	4	87	83	20	11	-	3	-	5	-	2	-	9	
840202	191620	4	87	82	25	15	-	3	-	5	0	-	9		
840202	191820	4	88	82	28	20	-	2	-	4	1	-	9		
840202	192120	4	87	80	31	25	-	3	-	4	1	-	9		
840202	192620	4	86	77	33	29	-	3	-	4	1	-	9		
840202	193520	4	82	73	37	33	-	2	-	4	1	-	9		
840202	194520	4	78	69	38	33	-	3	-	4	1	-	9		
840202	195520	4	74	67	38	32	-	2	-	4	1	-	9		
840202	212722	4	45	45	28	22	-	3	-	4	0	-	8		
840202	214322	4	41	41	25	20	-	3	-	4	1	-	8		
840202	220422	4	37	38	23	18	-	3	-	4	1	-	8		
840202	222722	4	33	34	21	16	-	4	-	4	1	-	8		
840202	225622	4	29	30	18	14	-	3	-	4	2	-	6		
840202	232722	4	25	26	15	12	-	4	-	5	2	-	7		
840203	000922	4	21	22	13	10	-	4	-	5	3	-	7		
840203	004722	4	17	18	10	8	-	4	-	5	4	-	8		
840203	014122	4	13	14	7	5	-	5	-	6	4	-	8		
840203	024622	4	10	10	4	2	-	5	-	7	6	-	9		
840203	041322	4	6	6	2	1	-	5	-	6	5	-	3		
840203	064922	4	2	2	0	0	-	4	-	3	2	-	1		

UNCLASSIFIED

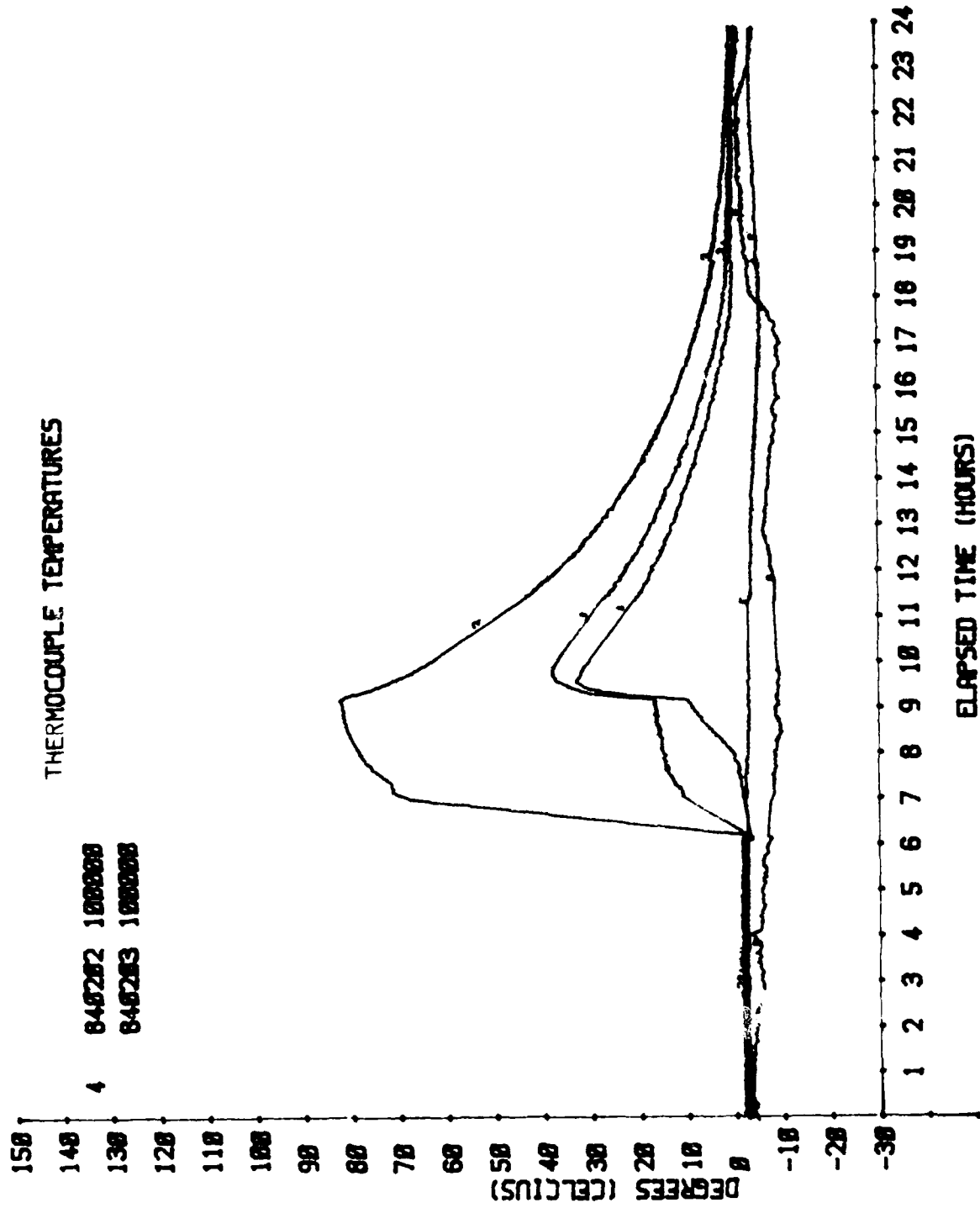


FIGURE D-10

UNCLASSIFIED

/D-29

TABLE D-11

DATE	TIME	VEH	THERMOCOUPLE TEMPERATURES							
			1	2	3	4	5	6	7	8
B40203	090048	4	0	1	0	1	4	3	2	3
B40203	181624	4	- 3	- 3	- 4	- 4	- 4	- 5	- 6	-11
B40203	204624	4	- 4	- 4	- 6	- 6	- 6	- 8	-10	-13
B40204	000859	4	- 7	- 8	- 9	-10	- 9	-13	-14	-16
B40204	044759	4	-11	-12	-13	-13	-13	-15	-16	-16

UNCLASSIFIED

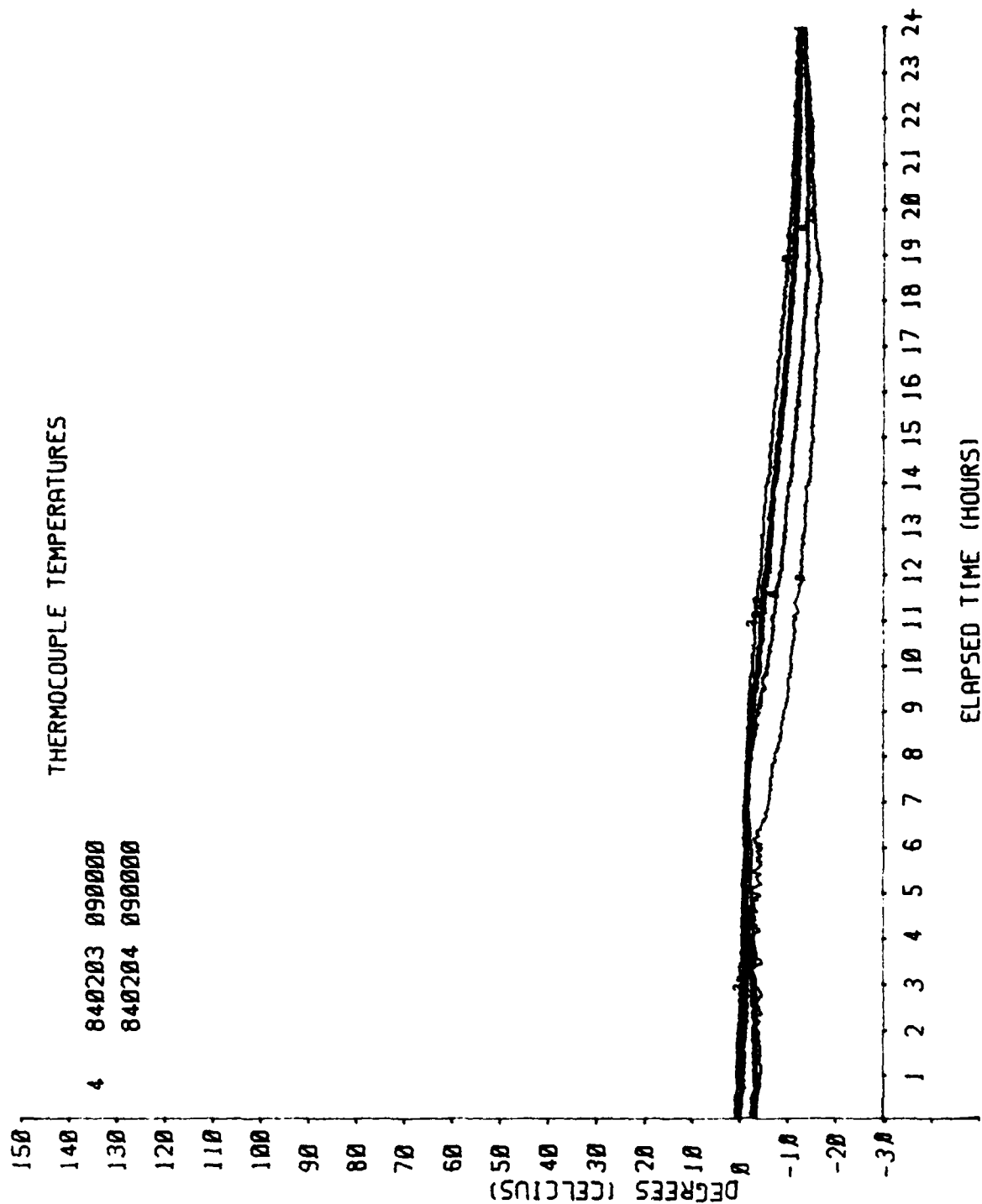


FIGURE D-11

UNCLASSIFIED

/D-31

TABLE D-12

DATE	TIME	VEH	THERMOCOUPLE TEMPERATURES							
			1	2	3	4	5	6	7	8
840204	091059	4	-13	-13	-14	-14	-13	-14	-14	-14
840204	092248	4	-13	-13	-14	-15	-8	-14	-14	-14
840204	092348	4	-7	-9	-13	-15	-7	-14	-13	-14
840204	092448	4	-1	-5	-12	-14	-8	-13	-13	-14
840204	092548	4	7	-1	-12	-14	-7	-13	-13	-14
840204	092748	4	-15	-5	-11	-13	-6	-13	-13	-14
840204	092848	4	25	11	-10	-13	-6	-13	-14	-14
840204	092948	4	31	17	-9	-13	-5	-12	-14	-14
840204	093048	4	37	24	-7	-13	-5	-13	-14	-14
840204	093148	4	39	30	-5	-13	-5	-12	-14	-14
840204	093248	4	46	37	-4	-12	-5	-12	-14	-14
840204	093548	4	52	40	-1	-12	-5	-13	-14	-14
840204	093748	4	55	44	0	-12	-5	-13	-14	-14
840204	093948	4	60	49	1	-11	-4	-12	-14	-14
840204	094148	4	66	55	4	-10	-5	-12	-14	-14
840204	094348	4	70	60	6	-9	-5	-11	-13	-14
840204	094648	4	71	60	9	-4	-5	-12	-14	-14
840204	094848	4	70	59	10	1	-5	-12	-13	-13
840204	095148	4	70	59	13	7	-5	-12	-13	-13
840204	095448	4	70	58	15	12	-5	-11	-13	-13
840204	095848	4	69	57	17	16	-5	-11	-13	-13
840204	100442	4	68	55	20	21	-5	-11	-13	-13
840204	101542	4	64	53	23	24	-5	-11	-12	-13
840204	102742	4	60	50	25	25	-6	-11	-12	-13
840204	103942	4	55	48	25	25	-6	-11	-12	-12
840204	105442	4	51	45	25	25	-6	-10	-11	-12
840204	111037	4	47	43	25	24	-6	-10	-11	-11
840204	112537	4	43	41	25	23	-6	-10	-11	-11
840204	114437	4	39	38	23	22	-7	-10	-10	-11
840204	120737	4	35	35	22	22	-7	-9	-9	-10
840204	123337	4	31	32	21	20	-7	-9	-9	-10
840204	130537	4	27	29	19	18	-7	-8	-8	-8
840204	133937	4	23	25	15	14	-7	-8	-8	-12
840204	141637	4	19	22	12	10	-8	-8	-8	-12
840204	150837	4	15	18	9	7	-8	-8	-9	-15
840204	160637	4	12	14	6	5	-8	-9	-11	-17
840204	165337	4	9	11	3	1	-9	-11	-13	-19
840204	180337	4	5	7	0	1	-11	-14	-16	-21
840204	192152	4	2	3	3	5	-12	-16	-10	-21
840204	203350	4	-2	-1	-7	-8	-14	-19	-21	-23
840204	220150	4	-5	-5	-10	-12	-16	-20	-22	-24
840205	000150	4	9	9	13	14	18	22	24	25
840205	023550	4	-12	-13	-16	-17	-20	-24	-25	-26

UNCLASSIFIED

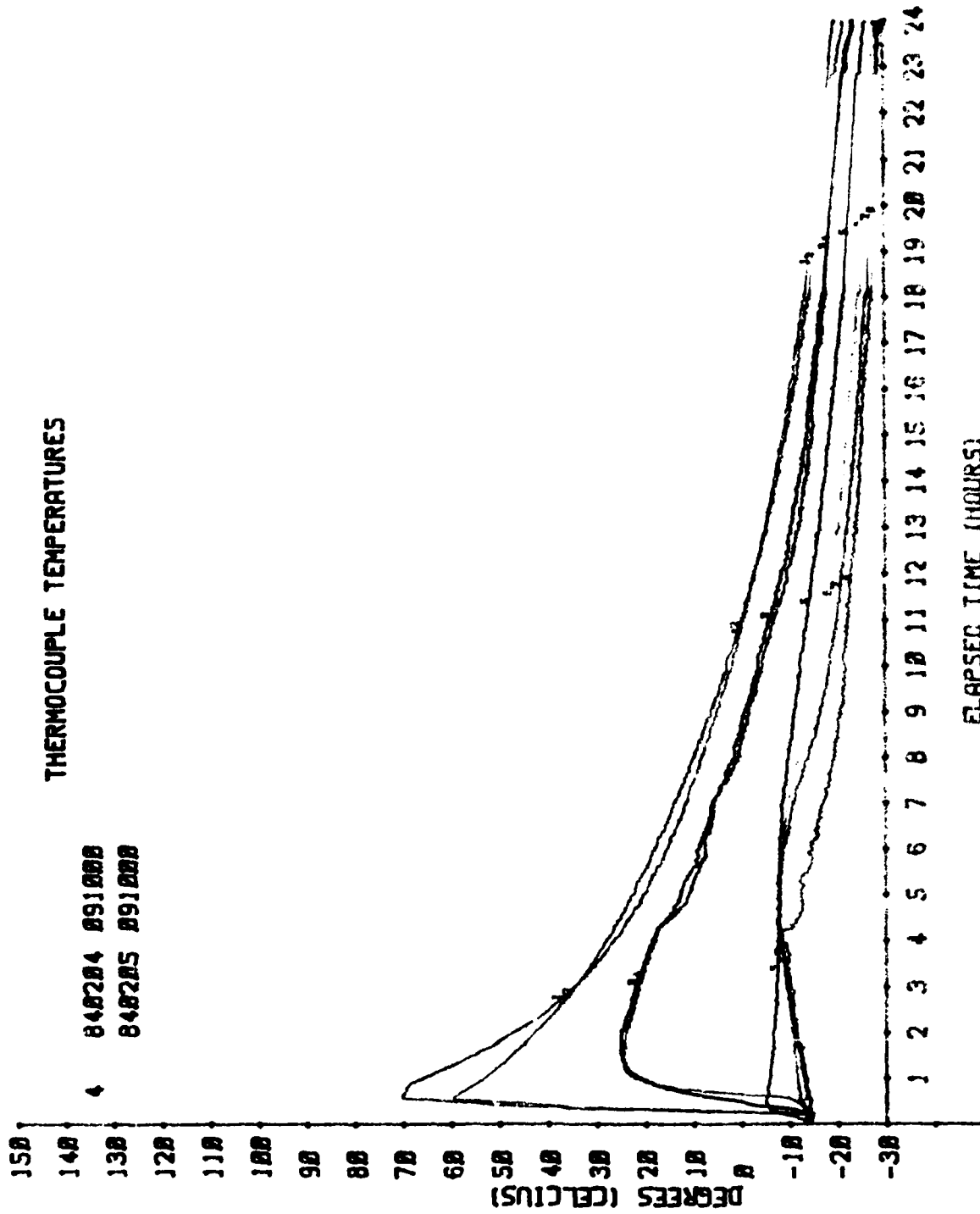


FIGURE D-12

UNCLASSIFIED

TABLE D-13

/D-33

			THERMOCOUPLE TEMPERATURES							
DATE	TIME	VEH	1	2	3	4	5	6	7	8
840205	115023	4	-22	-24	-25	-26	-25	-24	-25	-22
840205	120123	4	-22	-24	-25	-25	-20	-24	-24	-23
840205	121851	4	-22	-24	-24	-24	-16	-21	-24	-23
840205	134151	4	-22	-22	3	-22	-17	-20	-23	-22
840205	134251	4	-22	-23	24	-22	-17	-20	-22	-21
840205	134451	4	-23	-23	10	-22	-17	-19	-22	-22
840205	134551	4	-22	-23	17	-22	-17	-19	-23	-22
840205	134751	4	-23	-22	11	-22	-17	-20	-22	-22
840205	134851	4	-23	-22	2	-22	-17	-20	-23	-22
840205	134951	4	-23	-22	2	-22	-17	-19	-22	-22
840205	135051	4	-23	-22	7	-22	-17	-20	-23	-22
840205	135151	4	-23	-22	21	-22	-17	-20	-23	-22
840205	135251	4	-23	-22	13	-22	-16	-20	-23	-22
840205	135351	4	-22	-21	52	-21	-16	-20	-22	-20
840205	135451	4	-22	-21	41	-21	-16	-20	-22	-22
840205	135551	4	-22	-21	23	-21	-16	-20	-22	-23
840205	135651	4	-22	-21	12	-21	-16	-20	-23	-23
840205	135751	4	-22	-21	19	-21	-16	-20	-23	-23
840205	135851	4	-22	-21	38	-21	-16	-20	-22	-21
840205	135951	4	-22	-21	59	-21	-16	-20	-23	-22
840205	140051	4	-22	-20	64	-21	-15	-20	-22	-22
840205	142338	4	-20	-22	40	-21	-16	-20	-23	-23
840205	142438	4	-13	-16	5	-21	-16	-20	-23	-23
840205	142538	4	4	-10	-12	-23	-15	-19	-22	-23
840205	142638	4	3	-6	-9	-23	-15	-19	-23	-23
840205	142738	4	9	-2	-10	-23	-15	-19	-23	-23
840205	142838	4	20	4	-11	-23	-16	-20	-23	-22
840205	142938	4	23	9	-10	-23	-15	-19	-23	-22
840205	143038	4	27	13	-11	-23	-15	-19	-23	-23
840205	143238	4	33	19	-10	-23	-15	-20	-23	-22
840205	143438	4	37	24	-10	-22	-15	-19	-23	-22
840205	143638	4	41	28	-8	-22	-15	-19	-23	-23
840205	143938	4	45	33	-7	-22	-15	-19	-23	-22
840205	144338	4	49	38	-5	-22	-15	-19	-23	-22
840205	144738	4	54	43	-2	-21	-15	-20	-23	-22
840205	145138	4	58	47	-1	-21	-15	-19	-23	-21
840205	145638	4	61	51	1	-21	-16	-19	-23	-22
840205	150238	4	65	56	4	-20	-15	-19	-23	-22
840205	151222	4	66	54	6	-15	-15	-18	-22	-21
840205	151722	4	65	52	4	-10	-15	-19	-22	-20
840205	153332	4	60	46	4	-9	-15	-18	-22	-20
840205	154332	4	56	43	3	-9	-16	-19	-22	-22
840205	155332	4	52	39	3	-8	-16	-18	-22	-22
840205	160332	4	48	36	2	-8	-16	-19	-22	-22
840205	161432	4	44	34	2	-7	-16	-19	-22	-21
840205	162032	4	42	31	1	-6	***	-20	-22	-22
840205	163232	4	37	28	0	-8	-6	-21	-20	-21
840205	163332	4	37	28	0	-7	-2	-15	-20	-21
840205	163432	4	37	28	1	-8	-1	-10	-21	-21
840205	164932	4	33	24	-2	-10	1	-10	-22	-22
840205	170432	4	28	21	-3	-12	1	-10	-22	-23
840205	172232	4	24	17	-4	-11	-0	-12	-23	-23
840205	174232	4	20	13	-7	-9	-2	-12	-22	-23
840205	175632	4	18	11	***	-10	-2	-12	-22	***
840205	175703	4	18	11	***	-11	-2	-12	-23	***
840205	175720	4	18	11	***	-11	-2	-12	-23	***
840205	175815	4	17	11	***	-11	-2	-12	-23	***
840205	180136	4	16	10	***	-12	-3	-13	-22	***
840205	180949	4	16	9	***	-12	-3	-12	-23	***

UNCLASSIFIED

UNCLASSIFIED

/D34

TABLE D-13 (Cont'd)

840205	181054	4	15	9	***	-12	-3	-12	-23	***
840205	181417	4	15	8	***	-12	-4	-13	-22	***
840205	181518	4	15	9	0	-12	-4	-13	-22	***
840205	181611	4	14	8	***	-12	-4	-13	-22	-1
840205	181659	4	14	8	***	-12	-4	-13	-22	-1
840205	182030	4	14	7	***	-12	-4	-13	-23	***
840205	182955	4	12	5	***	-11	-4	-12	-21	***
840205	183049	4	12	5	***	-11	-4	-13	-21	***
840205	183233	4	12	5	***	-11	-5	-12	-21	***
840205	183314	4	12	4	***	-12	-5	-13	-22	***
840205	183328	4	12	5	***	-11	-4	-13	-22	***
840205	183413	4	12	5	***	-12	-5	-13	-22	97
840205	183513	4	12	5	-11	-11	-5	-13	-21	-24
840205	185413	4	9	2	-13	-15	-6	-13	-23	-23
840205	193013	4	5	2	-15	-17	-7	-14	-22	-22
840205	210034	4	-3	-8	-16	-18	-7	-13	-22	-22
840205	220734	4	-2	-12	-17	-19	-9	-13	-21	-21
840205	234034	4	-11	-15	-18	-19	-11	-14	-21	-20
840205	142238	4	-22	-19	63	-19	-15	-20	-23	-22
840205	142338	4	-20	-22	40	-21	-16	-20	-23	-23
840205	142438	4	-13	-16	-5	-21	-16	-20	-23	-23
840205	142538	4	-4	-10	-12	-23	-15	-19	-22	-23
840205	142638	4	3	-6	-9	-23	-15	-19	-23	-23
840205	142738	4	9	-2	-10	-23	-15	-19	-23	-23
840205	142838	4	20	4	-11	-23	-16	-20	-23	-22
840205	142938	4	23	9	-10	-23	-15	-19	-23	-22
840205	143038	4	27	13	-11	-23	-15	-19	-23	-23
840205	143238	4	33	19	-10	-23	-15	-20	-23	-22
840205	143438	4	37	24	-10	-22	-15	-19	-23	-22
840205	143638	4	41	28	-8	-22	-15	-19	-23	-23
840205	143938	4	45	33	-7	-22	-15	-19	-23	-22
840205	144338	4	49	38	-5	-22	-15	-19	-23	-22
840205	144738	4	54	43	-2	-21	-15	-20	-23	-22
840205	145138	4	58	47	-1	-21	-15	-19	-23	-21
840205	145638	4	61	51	1	-21	-16	-19	-23	-22
840205	150238	4	65	56	4	-20	-15	-19	-23	-22
840205	151222	4	66	54	6	-15	-15	-18	-22	-21
840205	151722	4	65	52	4	-10	-15	-19	-22	-20
840206	000034	4	-11	-16	-18	-19	-11	-15	-20	-20
840206	030034	4	-15	-18	-19	-19	-14	-16	-20	-20
840206	081349	4	10	21	21	22	10	19	22	22
840206	112904	4	-19	-20	-20	-19	-18	-17	-18	-10

UNCLASSIFIED

UNCLASSIFIED

/D-35

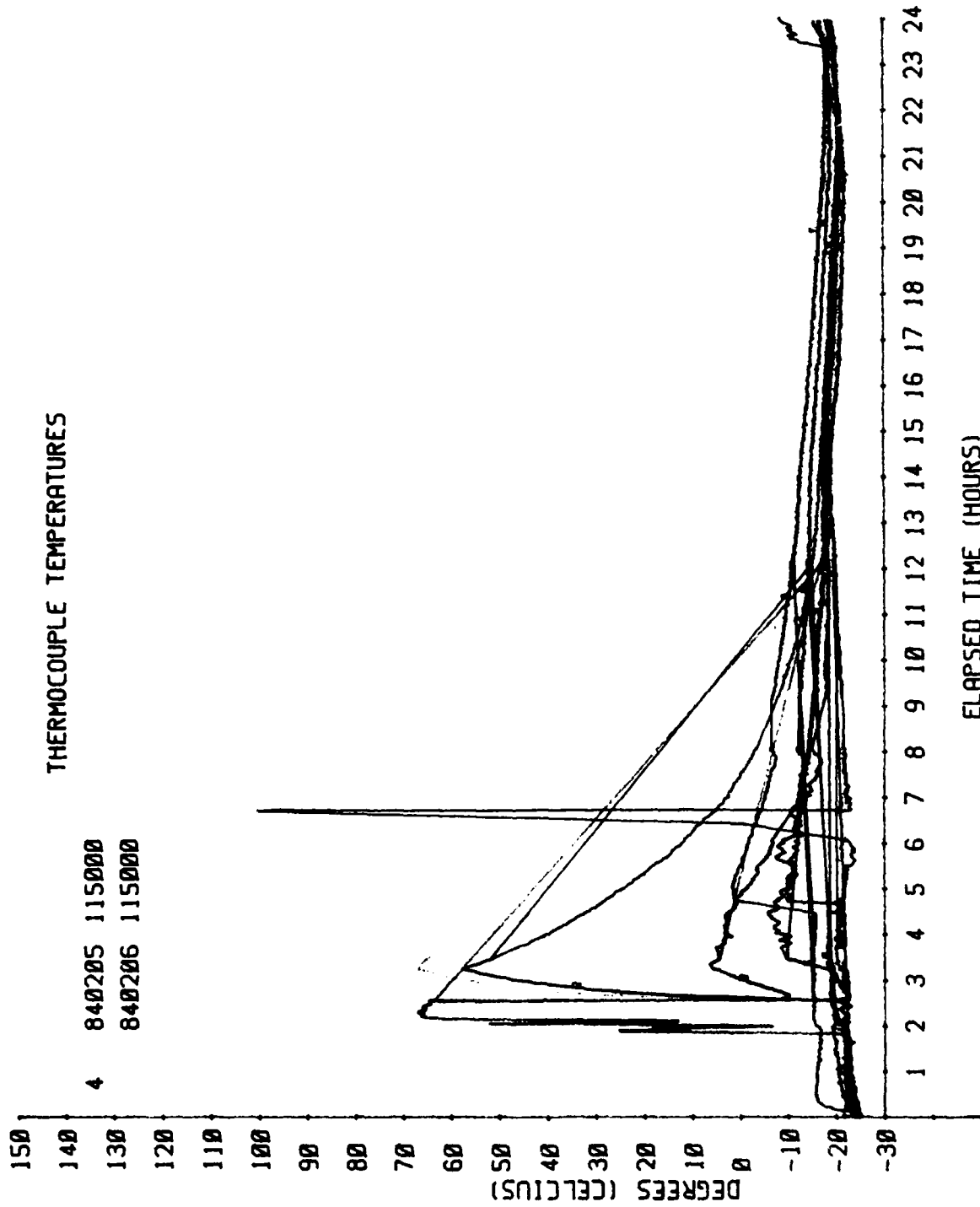


FIGURE D-13

UNCLASSIFIED

UNCLASSIFIED

/D-36

TABLE D-14

DATE	TIME	VEH	THERMOCOUPLE TEMPERATURES							
			1	2	3	4	5	6	7	8
840206	110004	4	-19	-20	-20	-20	-18	-18	-20	-18
840206	120404	4	-20	-19	-18	-18	-16	-14	-17	-10
840206	122604	4	-20	-19	-18	-18	-14	-10	-15	-8
840206	134804	4	-19	-17	-15	-16	-10	-7	-12	-8
840206	181304	4	-16	-14	-14	-14	-10	-12	-14	-16
840206	181404	4	-16	-14	-14	-15	***	-12	-13	-15
840206	182904	4	-16	-14	-14	-15	***	-13	-14	-16
840206	183004	4	-16	-14	-14	-14	***	-13	-14	-16
840206	185604	4	-16	-15	-14	-15	***	-14	-14	-16
840206	185704	4	-16	-15	-15	-15	***	-14	-14	-16
840206	185804	4	-16	-15	-15	-15	13	-14	-15	-16
840206	194204	4	-16	-15	-15	-16	11	-9	-15	-17
840206	212307	4	-16	-15	-16	-16	7	-7	-17	-17
840206	222507	4	-16	-16	-16	-16	3	-9	-18	-18
840206	235225	4	-16	-16	-17	-17	-1	-10	-19	-19
840207	013425	4	-16	-17	-18	-18	-5	-12	-19	-19
840207	042525	4	-17	-17	-17	-18	-9	-14	-18	-18
840207	102741	4	-17	-17	-16	-16	-11	-12	-14	-12

UNCLASSIFIED

UNCLASSIFIED

/ D-37

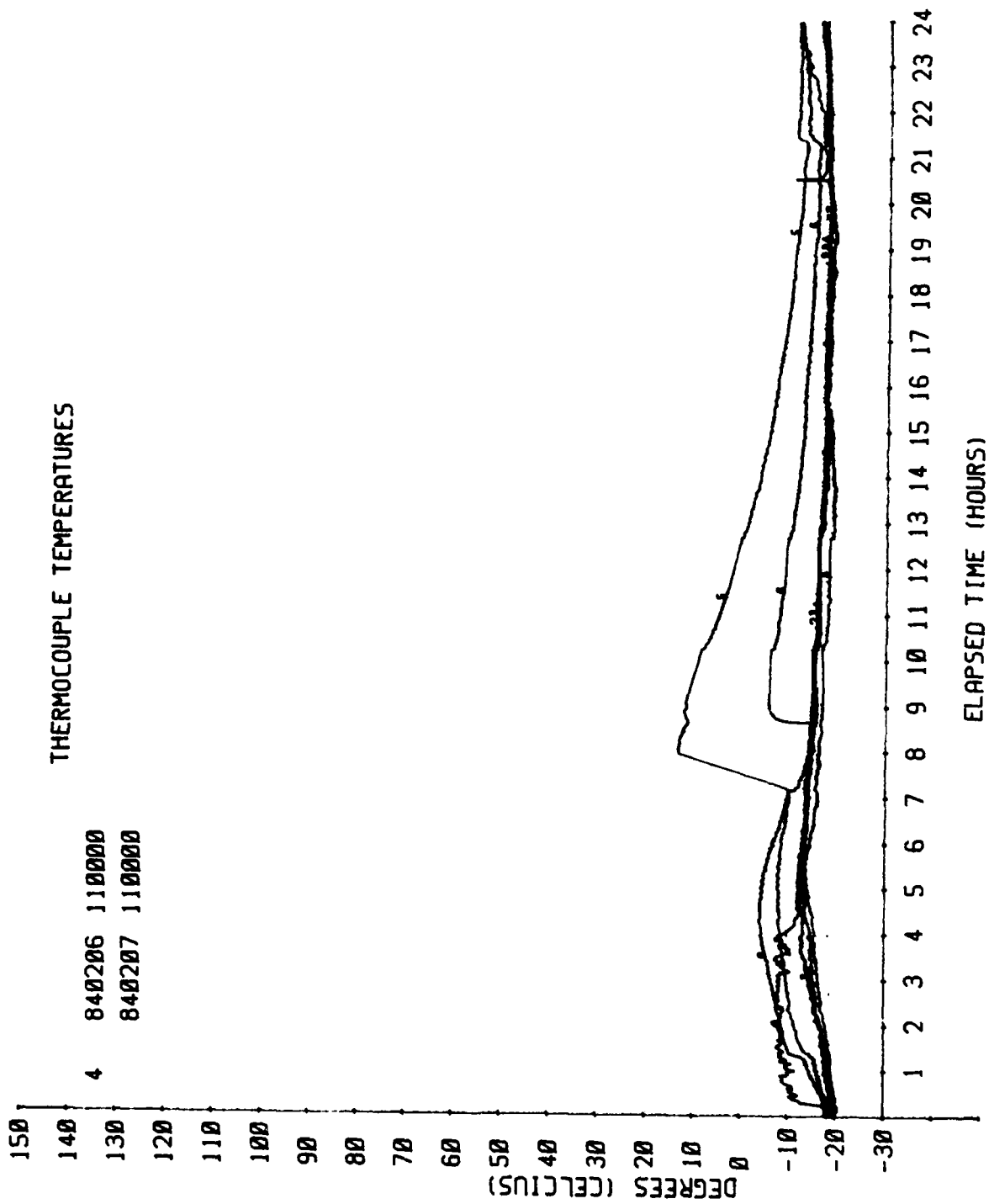


FIGURE D-14

UNCLASSIFIED

UNCLASSIFIED

/D-38

TABLE D-15

THERMOCOUPLE TEMPERATURES

DATE	TIME	VEH	1	2	3	4	5	6	7	8
840207	075025	4	-17	-18	-18	-18	-12	-15	-18	-17
840207	103441	4	-17	-17	-16	-17	-11	-12	-14	-12
840207	122639	4	-16	-15	-13	-13	-9	-6	-7	-7
840207	134439	4	-16	-12	-11	-10	-7	-4	-8	-7
840207	173229	4	-12	-9	-9	-9	-7	-4	-9	-11
840207	235404	4	-11	-12	-12	-12	-9	-7	-13	-13

UNCLASSIFIED

UNCLASSIFIED

/ D-39

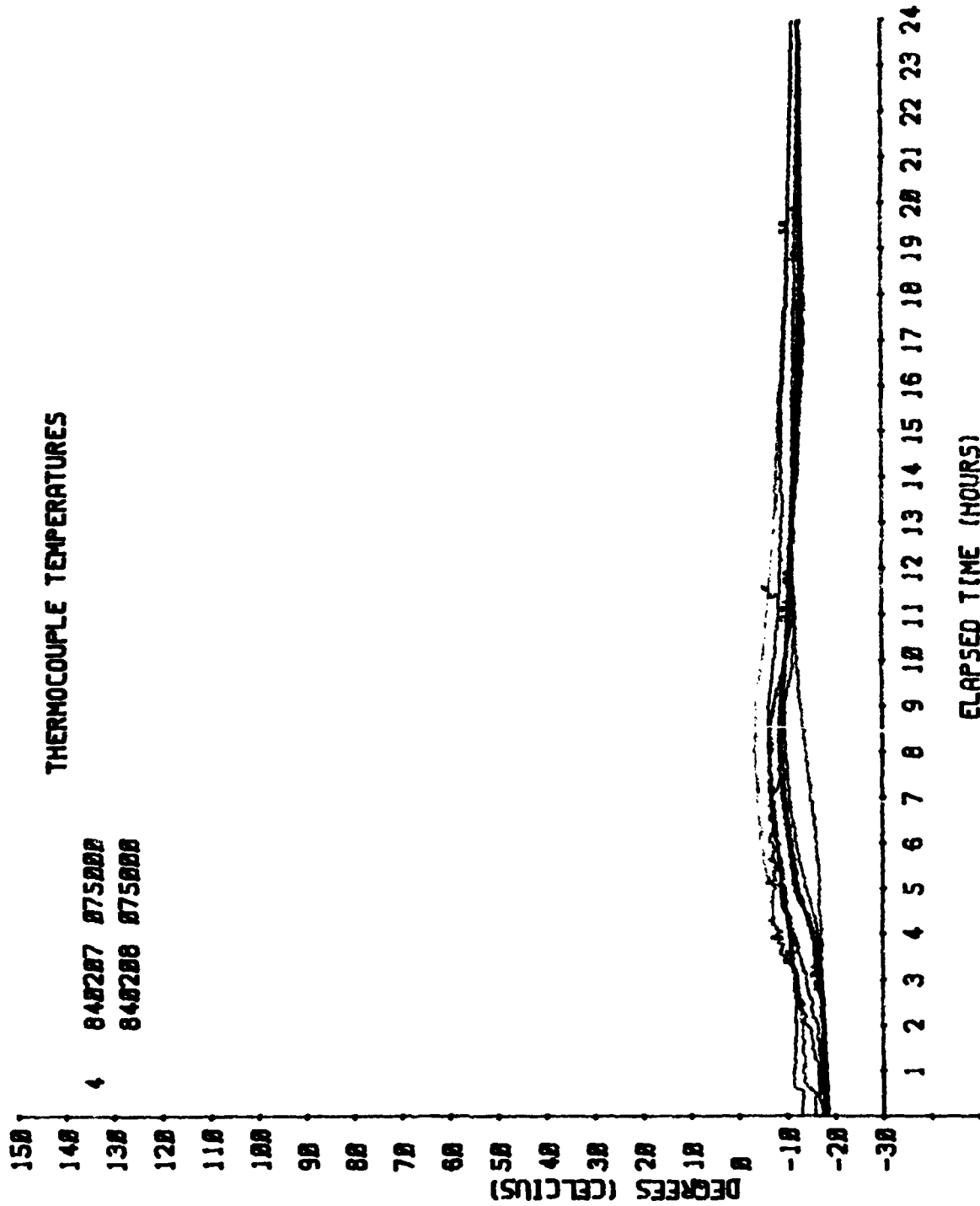


FIGURE D-15

UNCLASSIFIED

UNCLASSIFIED

TABLE D-16

/D-40

THERMOCOUPLE TEMPERATURES

DATE	TIME	VEH	1	2	3	4	5	6	7	8
840208	075004	4	-12	-13	-12	-12	-11	-11	-12	-12
840208	080848	4	-5	-8	-11	-12	-9	-9	-12	-12
840208	080948	4	-1	-6	-10	-12	-7	-8	-12	-12
840208	081148	4	13	3	-9	-12	-7	-7	-12	-11
840208	081248	4	19	8	-8	-12	-7	-7	-12	-11
840208	081448	4	26	15	-7	-12	-7	-7	-12	-11
840208	081648	4	32	21	-6	-12	-6	-7	-12	-11
840208	081848	4	36	25	-4	-12	-6	-7	-12	-11
840208	082148	4	41	31	-3	-11	-6	-6	-12	-11
840208	082448	4	46	35	-1	-11	-6	-6	-12	-11
840208	082848	4	50	40	1	-10	-6	-6	-12	-11
840208	083248	4	54	45	3	-10	-6	-6	-11	-11
840208	083748	4	57	49	5	-10	-6	-6	-11	-11
840208	084248	4	61	53	7	-10	-6	-6	-11	-11
840208	084948	4	66	58	10	-9	-6	-6	-11	-10
840208	085648	4	70	62	12	-9	-6	-6	-11	-11
840208	090548	4	74	67	16	-8	-6	-6	-11	-10
840208	091548	4	78	71	18	-8	-6	-6	-10	-10
840208	092648	4	81	71	22	-7	-6	-7	-10	-9
840208	093348	4	81	73	27	-6	-6	-6	-10	-9
840208	094348	4	83	76	31	-5	-6	-6	-9	-9
840208	095648	4	86	79	35	-4	-6	-6	-8	-8
840208	101248	4	89	83	38	-1	-6	-6	-8	-8
840208	103348	4	93	88	42	2	-5	-6	-7	-8
840208	105348	4	96	91	44	7	-6	-6	-6	-7
840208	111348	4	98	94	47	11	-6	-6	-6	-7
840208	114048	4	101	97	49	15	-5	-6	-5	-5
840208	121548	4	104	100	52	19	-5	-5	-4	-4
840208	124948	4	107	103	55	23	-4	-4	-3	-3
840208	131648	4	110	106	58	28	-4	-3	-3	-3
840208	131948	4	113	109	62	35	-4	-2	-1	-3
840208	132148	4	116	112	65	46	-3	-2	-1	-3
840208	132348	4	119	115	66	51	-3	-2	-1	-3
840208	132548	4	122	118	66	55	-3	-2	-2	-3
840208	132848	4	125	121	67	60	-3	-2	-1	-2
840208	133248	4	128	124	68	65	-3	-2	-1	-3
840208	134248	4	131	127	69	69	-3	-1	-0	-3
840208	140048	4	134	130	69	69	-2	-0	-0	-2
840208	140548	4	137	133	68	68	-1	-0	-0	-2
840208	141048	4	140	136	67	66	16	-1	1	-3
840208	142348	4	143	139	66	65	16	-0	-0	-3
840208	143648	4	146	142	64	62	15	-0	-0	-3
840208	144848	4	149	145	61	60	15	-0	-1	-4
840208	150348	4	152	148	60	58	15	-0	-1	-3
840208	151848	4	155	151	58	55	14	-1	-1	-4
840208	153448	4	158	154	55	53	13	-1	-1	-4
840208	155248	4	161	157	53	51	12	-2	-1	-3
840208	161148	4	164	160	50	48	11	-2	-2	-4
840208	163432	4	167	163	47	46	10	-2	-2	-3
840208	170032	4	170	166	45	43	9	-2	-2	-3
840208	170732	4	173	169	43	40	8	-3	-2	-2
840208	170932	4	176	172	41	32	9	-2	-2	-1
840208	171232	4	179	175	40	28	8	-3	-3	-3
840208	171732	4	182	178	37	23	8	-2	-2	-2
840208	172432	4	185	181	33	19	8	-3	-3	-3
840208	173032	4	188	184	30	15	7	-3	-3	-3
840208	174432	4	191	187	26	13	7	-3	-3	-3
840208	175632	4	194	190	22	9	7	-3	-3	-3
840208	181432	4	197	193	19	8	6	-3	-3	-3

UNCLASSIFIED

UNCLASSIFIED

/D-41

TABLE D-16 (Cont'd)

840208	183620	4	35	38	16	7	5	-	3	-	3	-	2	
840208	196020	4	32	34	14	6	5	-	3	-	3	-	3	
840208	192547	4	29	29	12	6	4	-	3	-	3	-	3	
840208	195447	4	25	25	9	3	3	-	3	-	3	-	3	
840208	203547	4	21	21	8	5	2	-	3	-	3	-	3	
840208	211747	4	18	17	6	3	2	-	4	-	3	-	4	
840208	220747	4	14	13	4	1	1	-	4	-	3	-	4	
840208	231147	4	11	9	2	0	0	-	4	-	4	-	4	
840209	002447	4	7	5	-	0	-	3	-	1	-	5	-	5
840209	021547	4	3	1	-	3	-	4	-	3	-	6	-	8
840209	043347	4	-	0	-	3	-	6	-	7	-	5	-	9
840209	074747	4	-	4	-	6	-	8	-	8	-	7	-	9

UNCLASSIFIED

ND-A195 288

IMPROVING LOW TEMPERATURE STARTABILITY OF M113
VEHICLES: HOT AIR HEATING TESTS(U) DEFENCE RESEARCH
ESTABLISHMENT SUFFIELD RALSTON (ALBERTA)

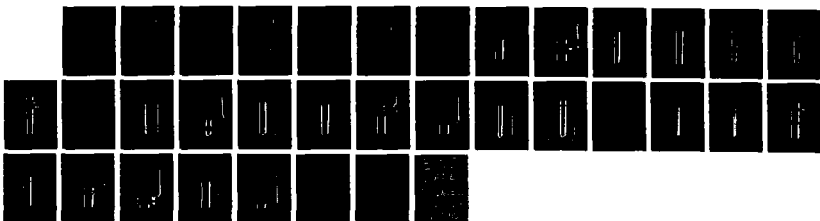
373

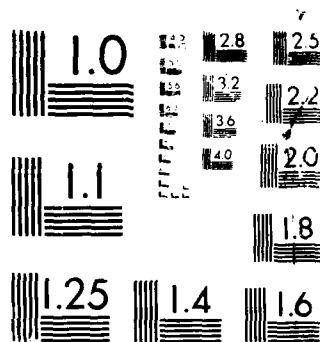
UNCLASSIFIED

T F STUPICH ET AL. MAR 88 DRES-SH-1165

F/O 19/3

NL





MICROSCOPIC RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

UNCLASSIFIED

/ D-42

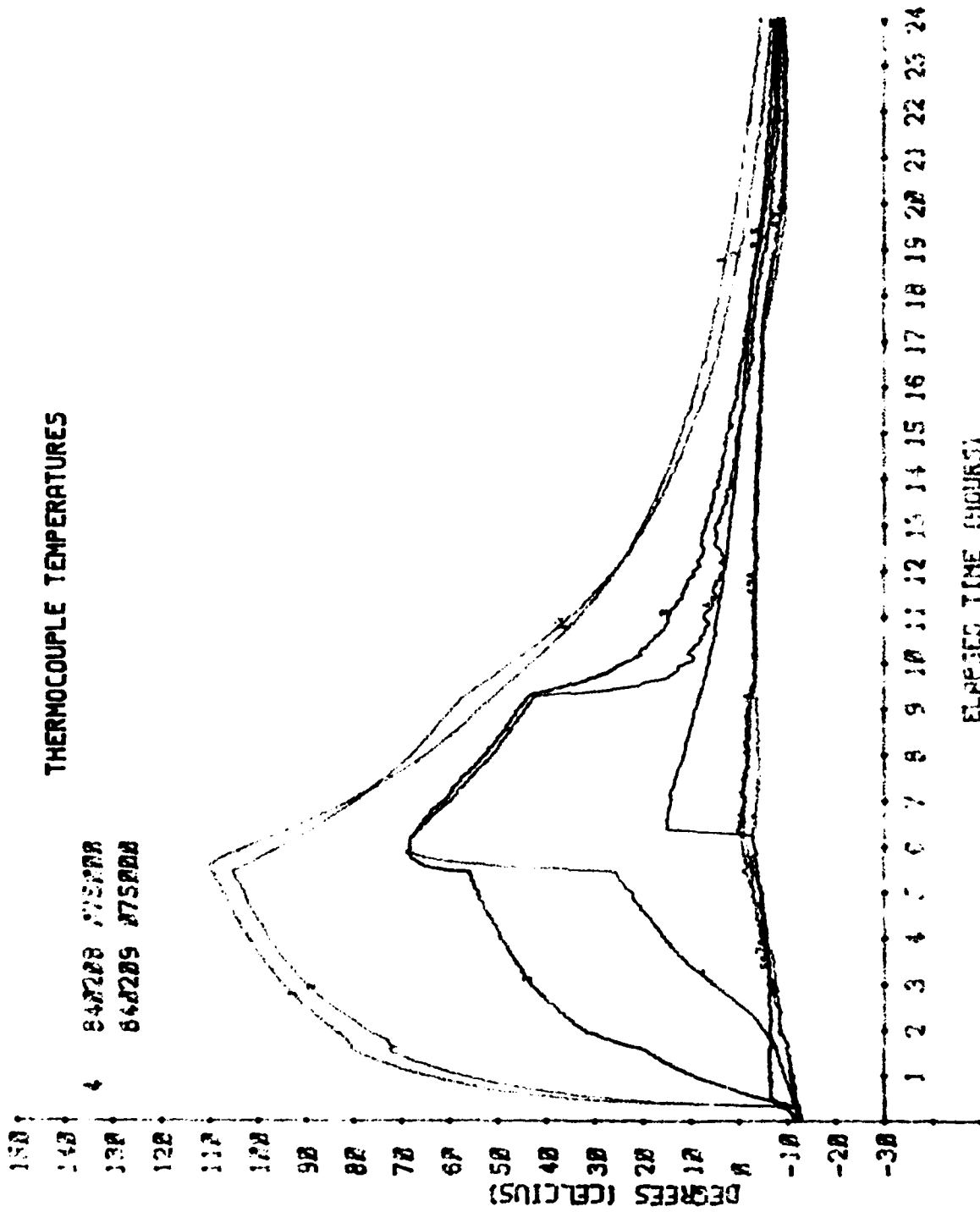


FIGURE D-16

UNCLASSIFIED

UNCLASSIFIED

/D-43

TABLE D-17

			THERMOCOUPLE TEMPERATURES							
DATE	TIME-VEH		1	2	3	4	5	6	7	8
840209	092651	4	- 5	- 7	- 7	- 8	- 7	- 8	- 7	- 7
840209	093351	4	1	- 2	- 6	- 8	- 7	- 9	- 8	- 7
840209	093551	4	13	- 2	- 4	- 6	- 6	- 8	- 8	- 7
840209	093651	4	25	14	- 4	- 6	- 6	- 9	- 7	- 7
840209	093751	4	34	20	- 2	- 6	- 6	- 9	- 8	- 7
840209	093851	4	37	24	- 1	- 5	- 6	- 8	- 8	- 7
840209	094051	4	44	31	1	- 5	- 6	- 8	- 7	- 7
840209	094251	4	49	36	2	- 5	- 6	- 8	- 7	- 7
840209	094651	4	51	41	4	- 5	- 6	- 8	- 8	- 7
840209	095051	4	54	45	6	- 4	- 6	- 8	- 7	- 7
840209	095551	4	58	50	8	- 4	- 6	- 8	- 7	- 7
840209	100051	4	62	54	10	- 4	- 6	- 8	- 7	- 6
840209	100751	4	66	59	13	- 3	- 6	- 8	- 7	- 6
840209	101451	4	68	61	19	0	- 6	- 8	- 7	- 6
840209	101851	4	68	60	19	4	- 6	- 8	- 7	- 5
840209	102551	4	68	57	18	10	- 6	- 7	- 7	- 5
840209	103651	4	65	54	18	14	- 6	- 7	- 5	- 4
840209	104951	4	60	51	19	14	- 5	- 7	- 6	- 4
840209	110251	4	56	47	18	11	- 5	- 7	- 6	- 4
840209	111651	4	51	44	16	10	- 5	- 6	- 5	- 3
840209	113051	4	47	41	15	9	- 4	- 5	- 5	- 2
840209	114651	4	42	37	13	7	- 4	- 4	- 3	- 0
840209	120551	4	38	34	12	7	- 3	- 3	- 2	- 2
840209	122551	4	34	31	12	6	- 2	- 2	- 2	- 1
840209	125151	4	30	27	11	6	- 1	- 0	- 1	- 2
840209	132151	4	26	23	8	3	- 0	1	1	4
840209	135751	4	22	19	7	3	0	2	2	5
840209	143644	4	18	16	6	3	1	3	3	5
840209	154141	4	14	13	6	6	3	5	4	2
840209	165541	4	11	10	6	6	9	7	5	0
840209	173741	4	10	8	5	5	10	3	2	- 1
840209	190136	4	8	7	4	4	6	0	- 1	- 3
840209	221259	4	4	3	0	- 2	- 0	- 5	- 6	- 8
840210	000909	4	1	- 1	- 4	- 3	- 3	- 7	- 7	- 9
840210	040709	4	- 3	- 4	- 5	- 5	- 5	- 7	- 7	- 7

UNCLASSIFIED

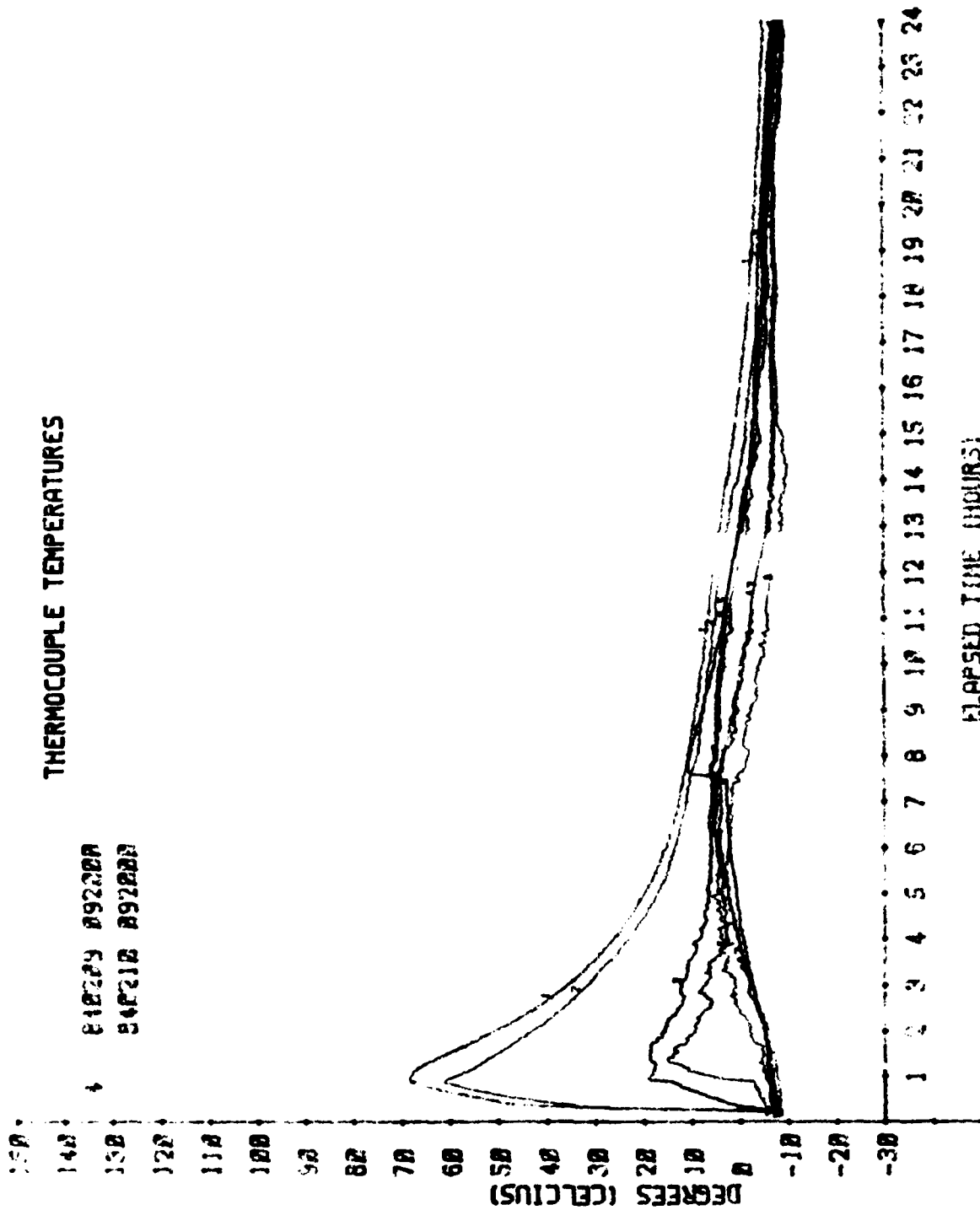


FIGURE D-17

UNCLASSIFIED

/D-45

TABLE D-18

DATE	TIME	VEH	THERMOCOUPLE TEMPERATURES							
			1	2	3	4	5	6	7	8
840210	094509	4	-	5	-	7	-	8	-	7
840210	125255	4	-	7	-	6	-	6	-	5
840210	134826	4	-	1	-	6	-	2	-	5
840210	134926	4	11	6	-	1	-	5	-	4
840210	135026	4	24	13	-	0	-	5	-	4
840210	135226	4	30	19	-	1	-	5	-	4
840210	135426	4	35	24	-	2	-	5	-	4
840210	135726	4	40	29	-	3	-	5	-	3
840210	140026	4	45	34	-	5	-	4	-	3
840210	140326	4	48	38	-	6	-	4	-	3
840210	140526	4	53	42	-	7	-	4	-	3
840210	140726	4	58	47	-	8	-	3	-	3
840210	140926	4	62	52	-	10	-	3	-	3
840210	141226	4	68	57	-	12	-	3	-	3
840210	141526	4	72	63	-	14	-	3	-	3
840210	141926	4	73	64	-	18	-	2	-	3
840210	142126	4	73	64	-	20	-	7	-	3
840210	142426	4	72	63	-	21	-	13	-	3
840210	142726	4	72	62	-	22	-	17	-	3
840210	143126	4	72	61	-	24	-	22	-	3
840210	143826	4	71	59	-	27	-	26	-	3
840210	144926	4	66	56	-	29	-	29	-	3
840210	150226	4	62	54	-	31	-	28	-	3
840210	151626	4	58	51	-	31	-	26	-	3
840210	153126	4	54	48	-	30	-	27	-	3
840210	154626	4	49	46	-	30	-	26	-	3
840210	160426	4	45	43	-	29	-	24	-	3
840210	162523	4	41	40	-	27	-	22	-	2
840210	164723	4	37	37	-	25	-	21	-	3
840210	171713	4	33	34	-	23	-	19	-	3
840210	175213	4	29	30	-	20	-	17	-	3
840210	203736	4	16	18	-	12	-	10	-	3
840210	214636	4	13	13	-	9	-	8	-	3
840210	220836	4	12	13	-	8	-	4	-	3
840210	223336	4	11	11	-	4	-	0	-	3
840210	234414	4	8	7	-	1	-	1	-	3
840211	014514	4	4	3	-	1	-	1	-	3
840211	055314	4	0	0	-	1	-	2	-	3

UNCLASSIFIED

UNCLASSIFIED

/ D-46

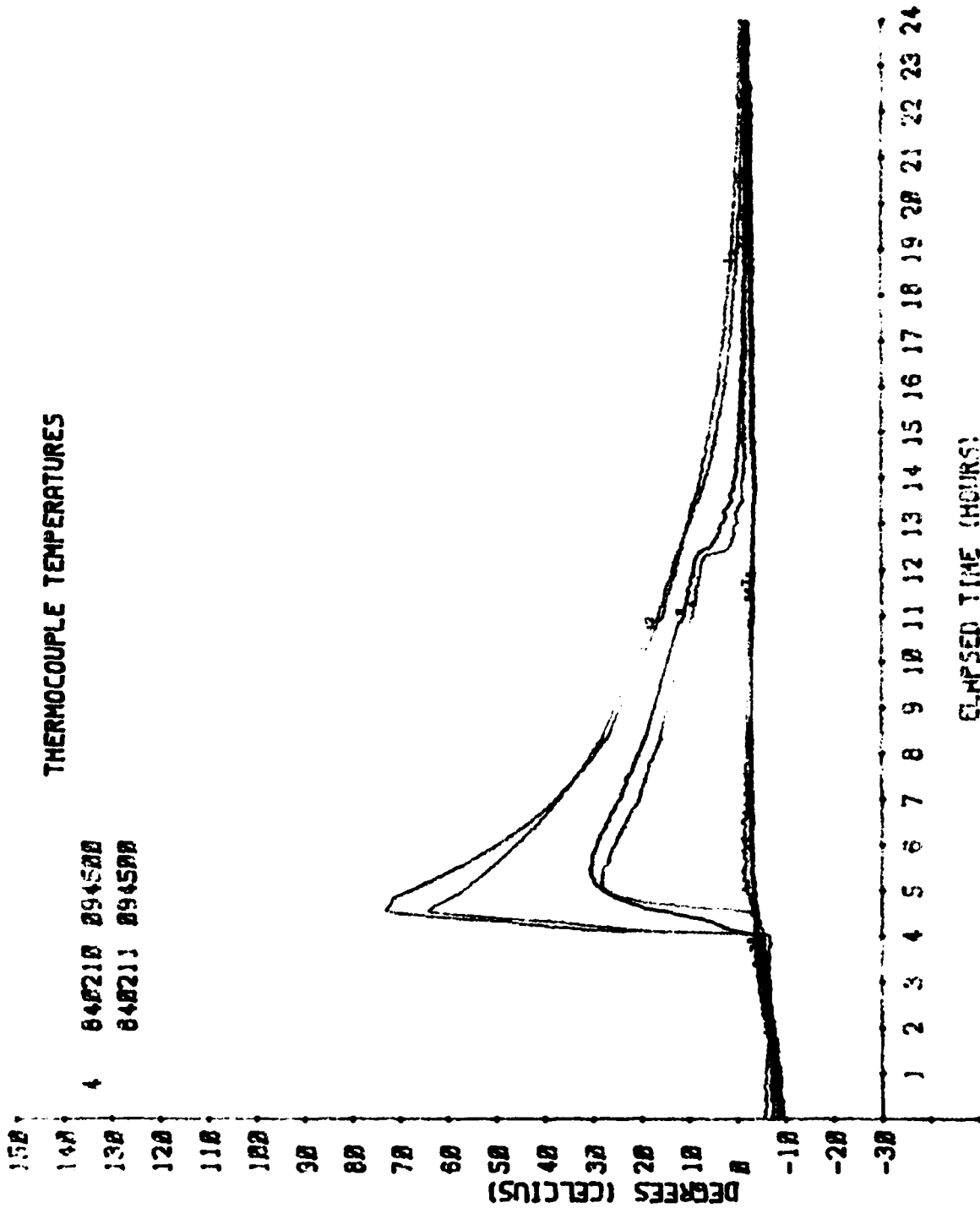


FIGURE D-18

UNCLASSIFIED

/D-47

**STARTING DATA
FROM CONTROL VEHICLE**

UNCLASSIFIED

UNCLASSIFIED

/ D-48

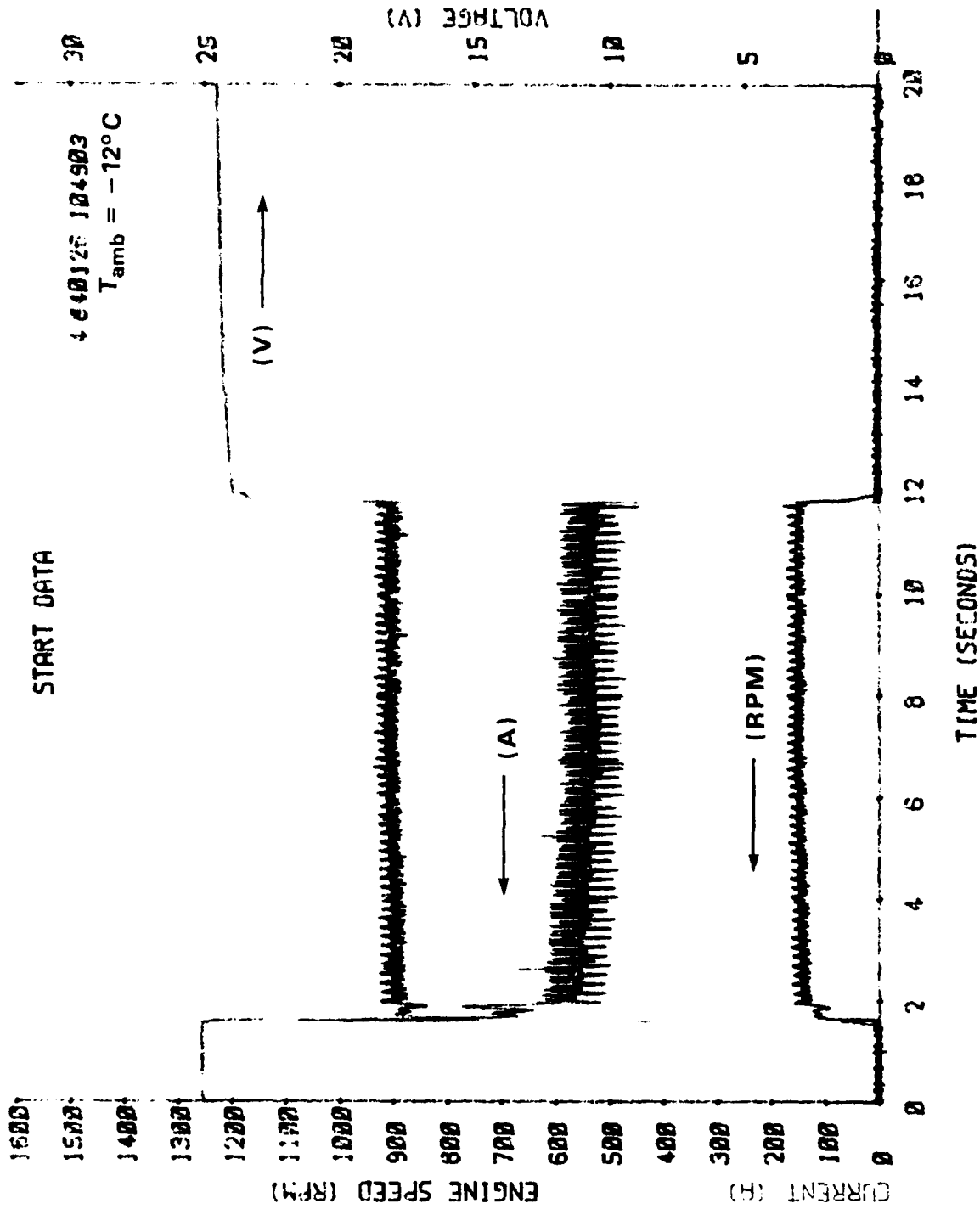


FIGURE D-19

UNCLASSIFIED

UNCLASSIFIED

/ D-49

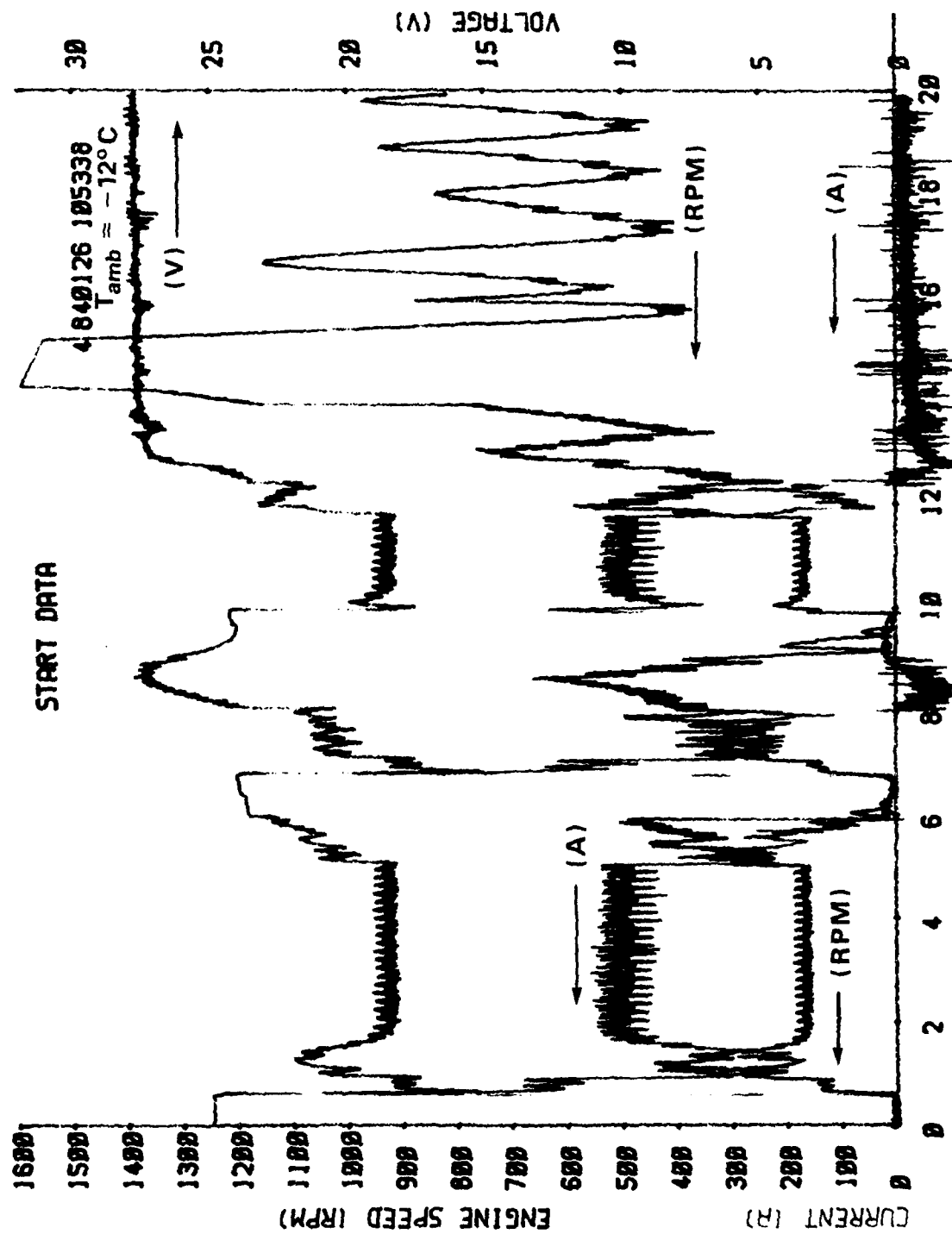


FIGURE D-20

UNCLASSIFIED

UNCLASSIFIED

/ D-50

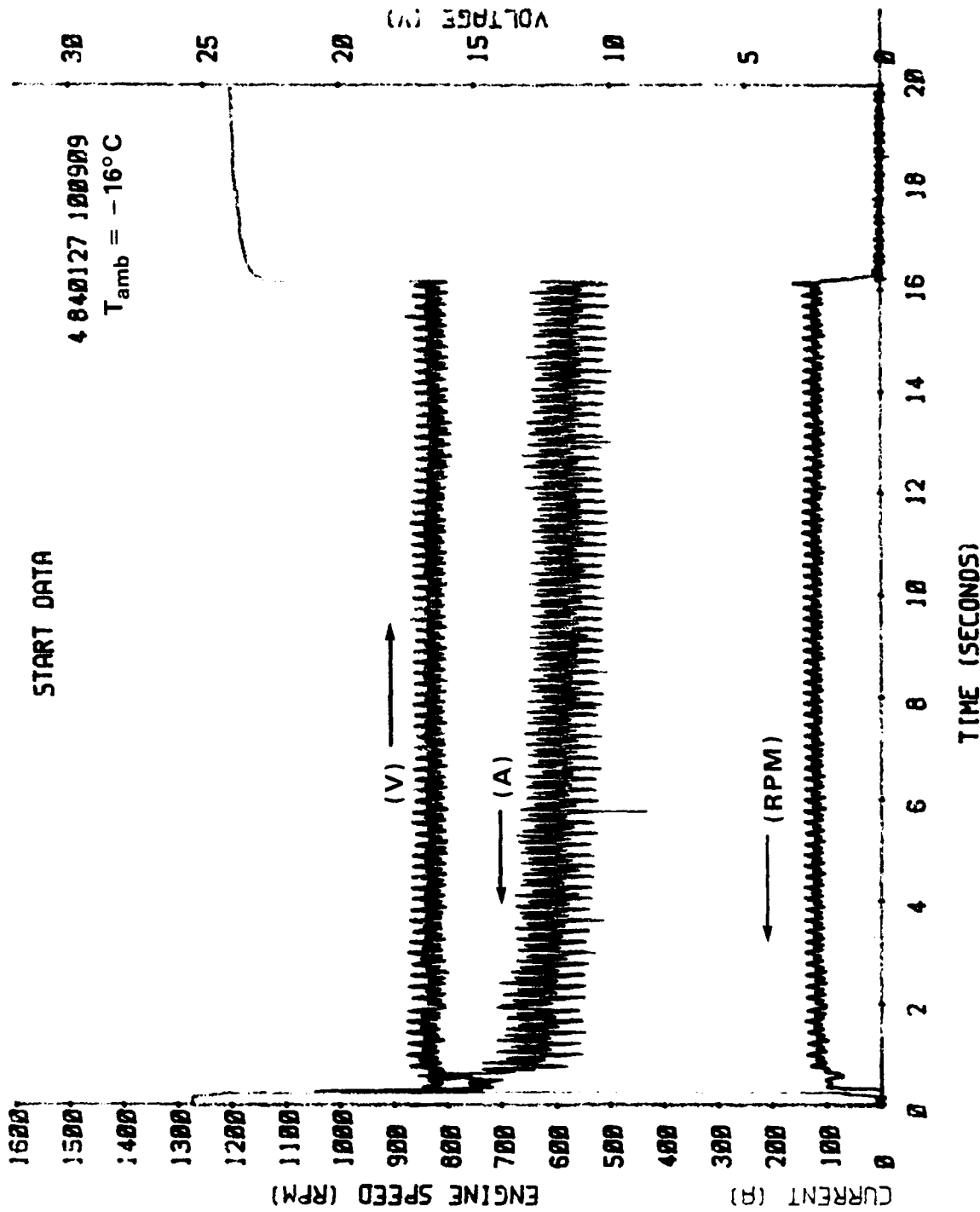


FIGURE D-21

UNCLASSIFIED

UNCLASSIFIED

/D-51

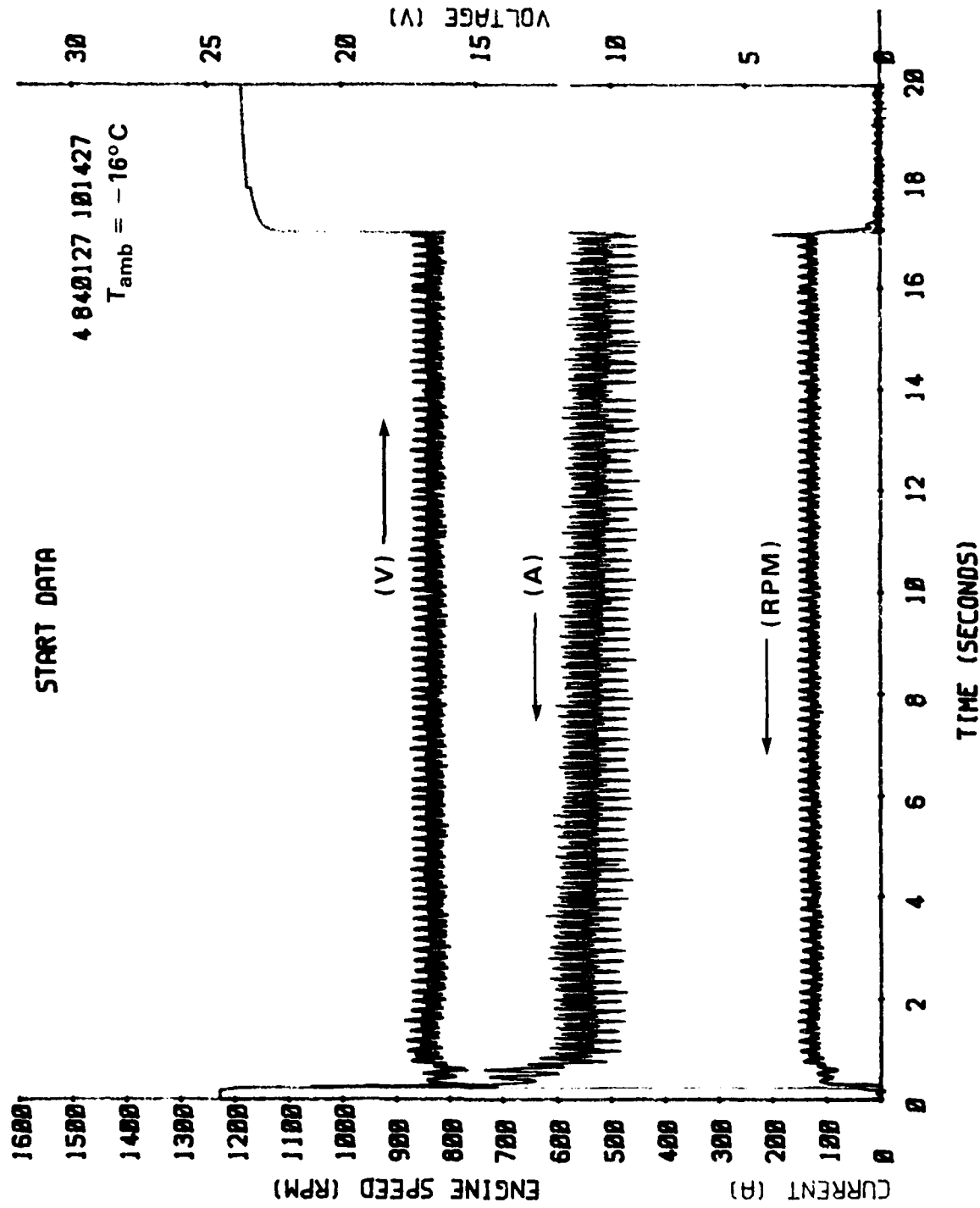


FIGURE D-22

UNCLASSIFIED

UNCLASSIFIED

/ D-52

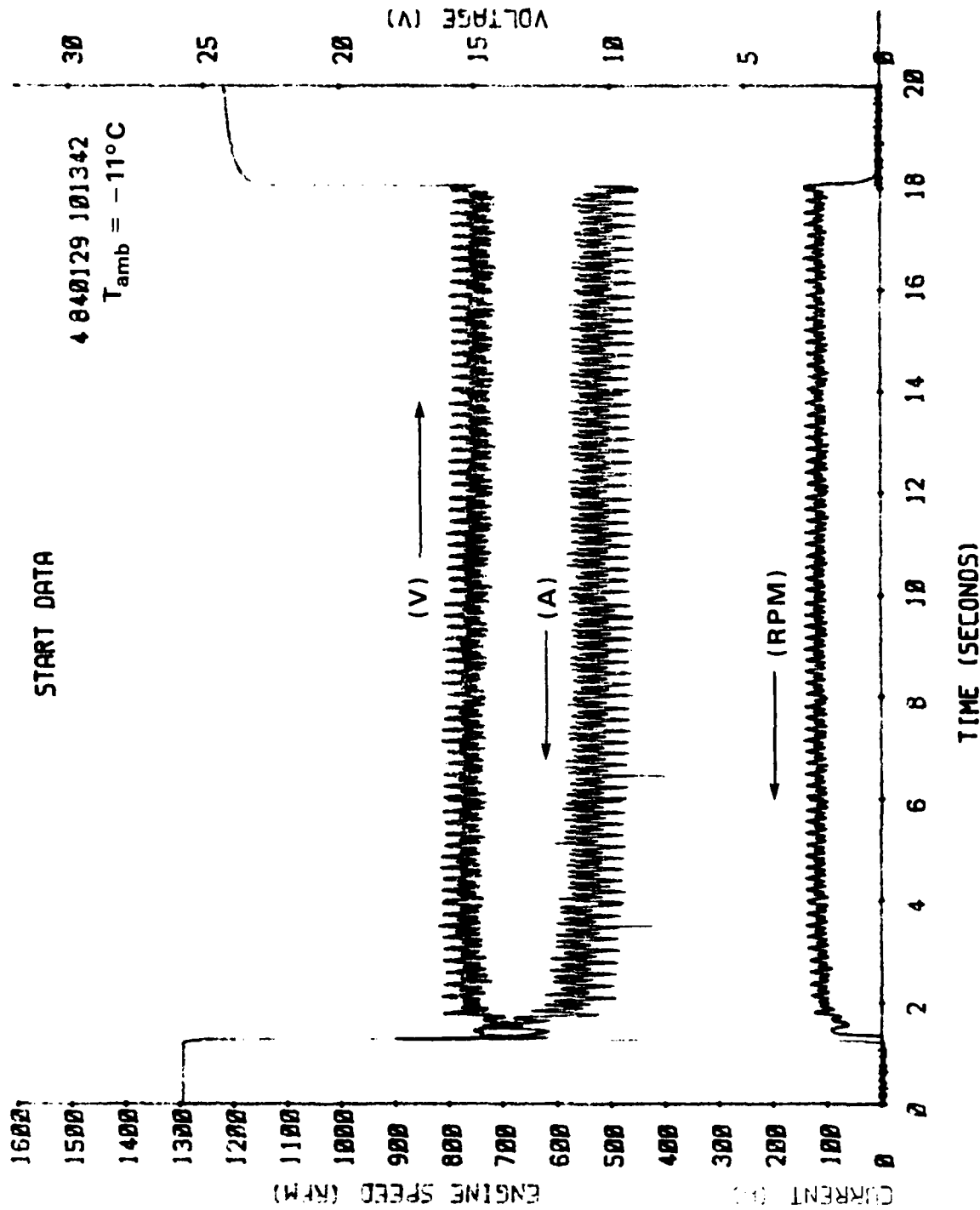
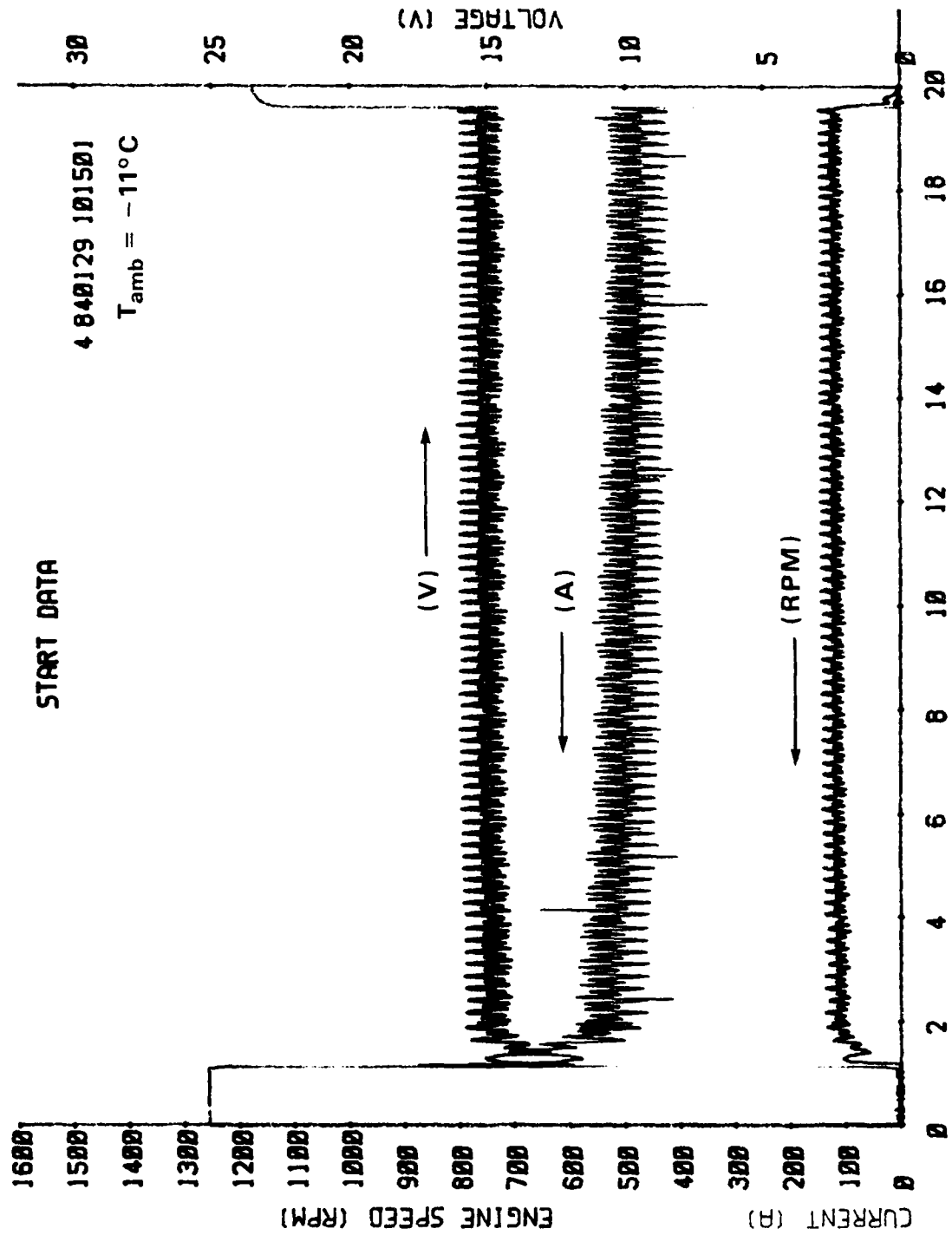


FIGURE D-23

UNCLASSIFIED

UNCLASSIFIED

/ D-53



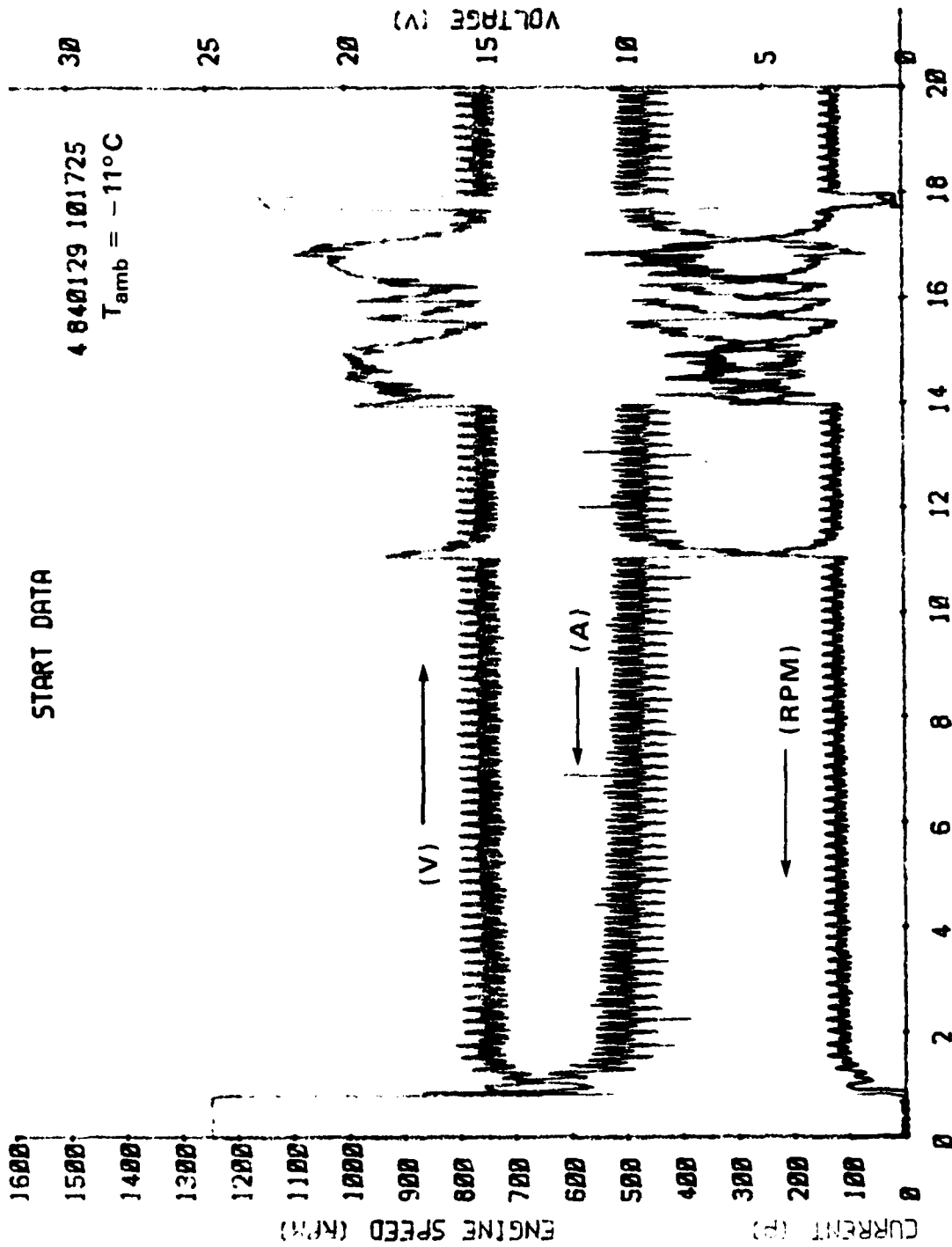
TIME (SECONDS)

FIGURE D-24

UNCLASSIFIED

UNCLASSIFIED

/D-54



TIME (SECONDS)

FIGURE D-25

UNCLASSIFIED

UNCLASSIFIED

/ D-55

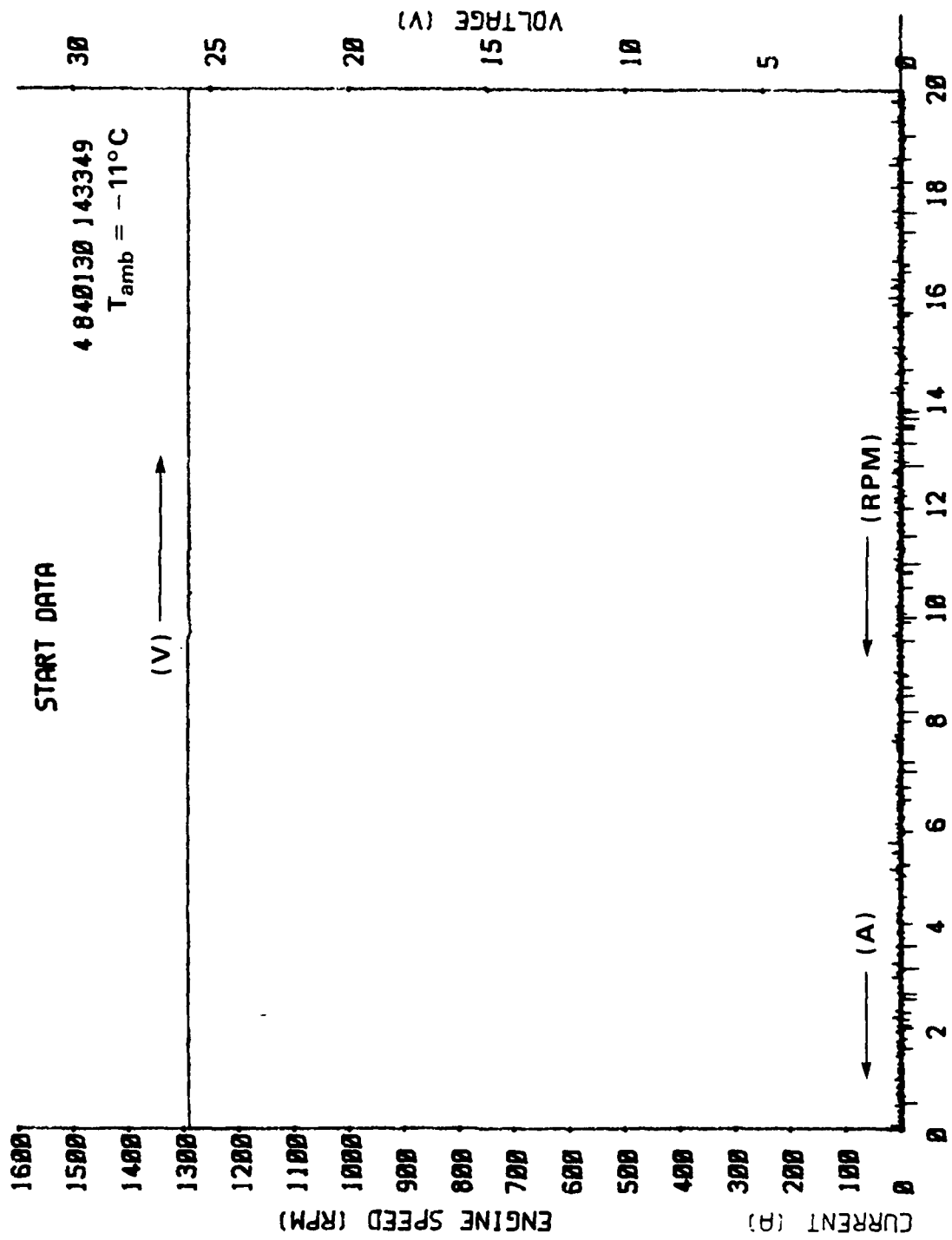


FIGURE D-26

UNCLASSIFIED

UNCLASSIFIED

D/56

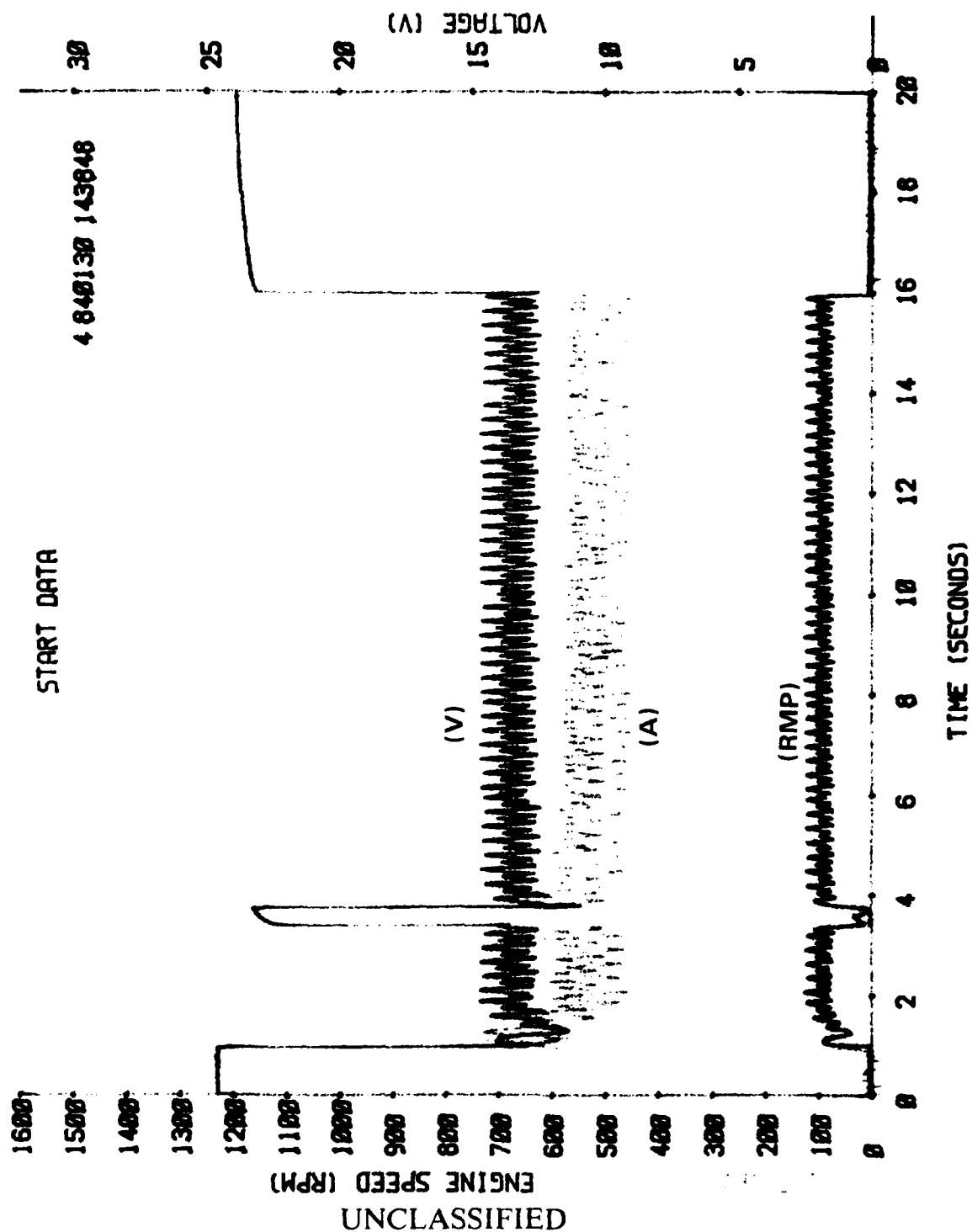


Figure D-27

UNCLASSIFIED

/D-57

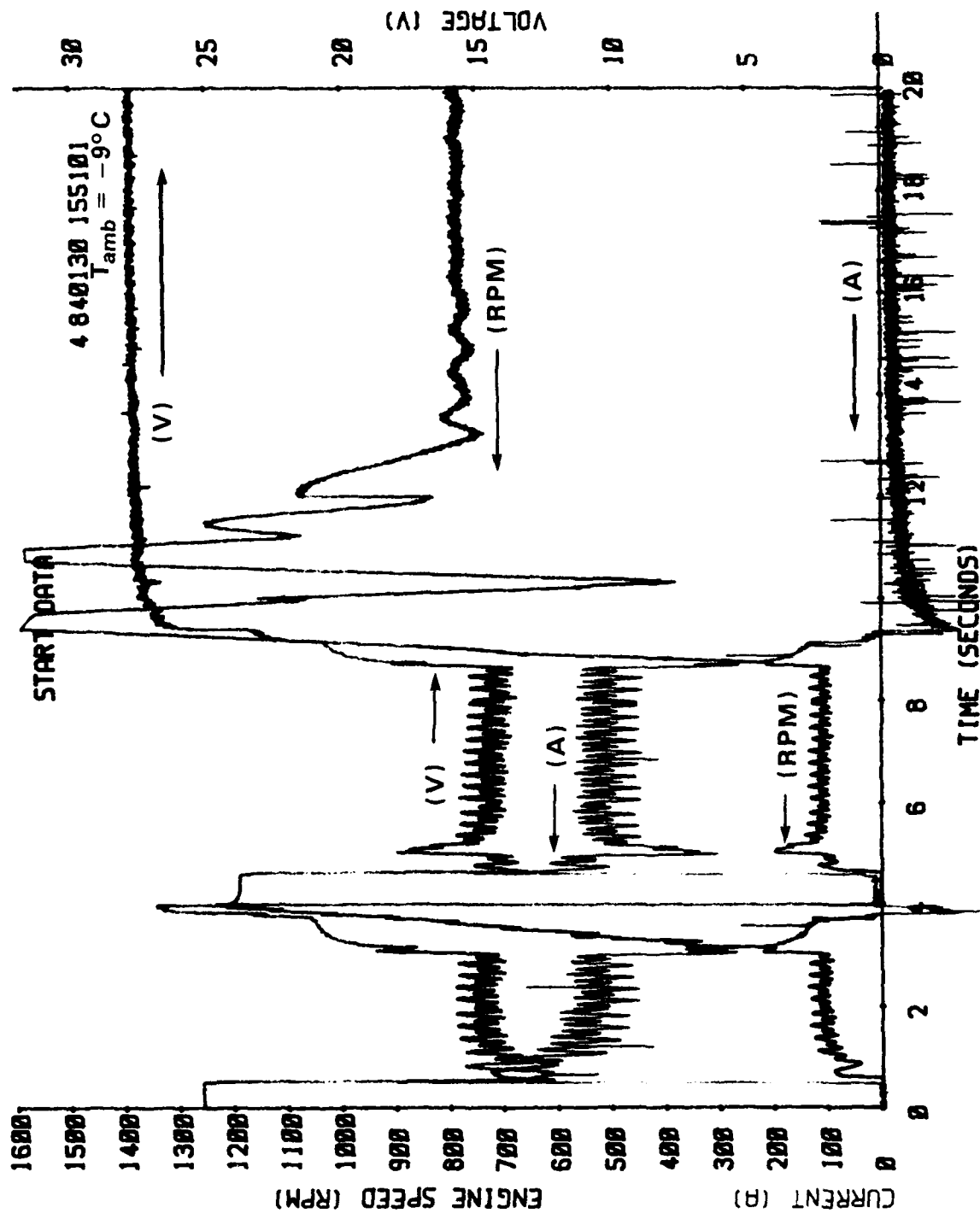
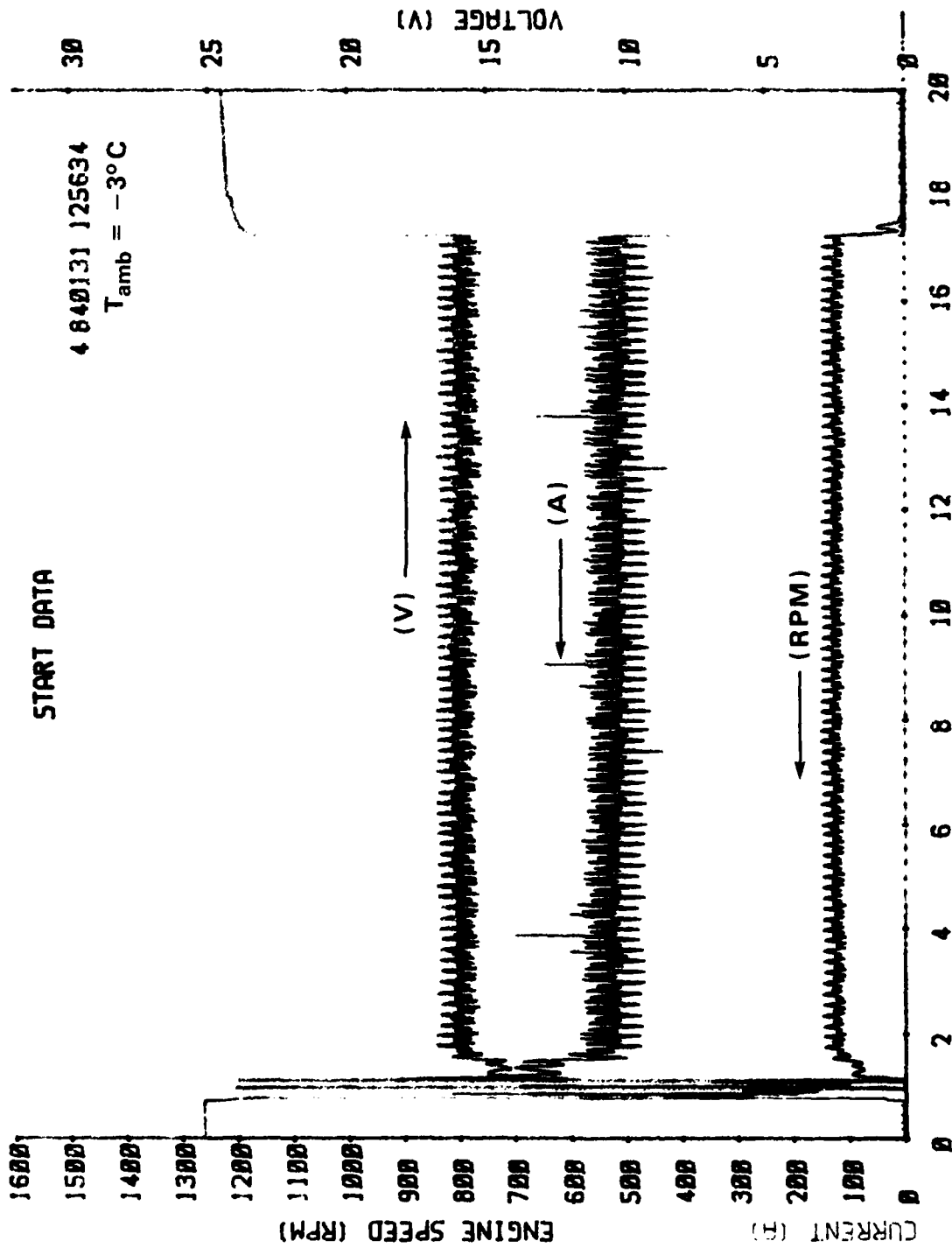


FIGURE D-28

UNCLASSIFIED

UNCLASSIFIED

/ D-58



TIME (SECONDS)

FIGURE D-29

UNCLASSIFIED

UNCLASSIFIED

/D-59

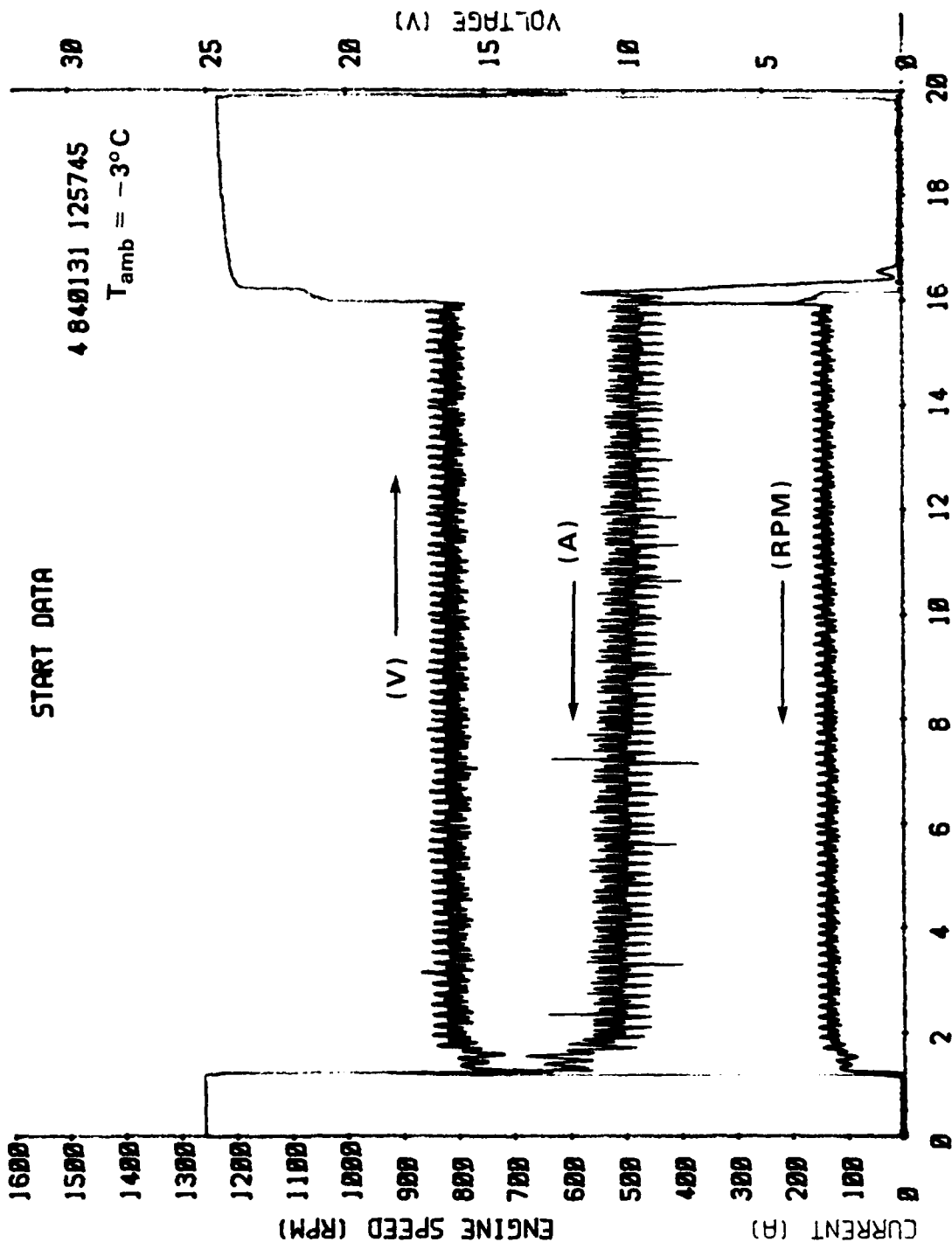


FIGURE D-30

UNCLASSIFIED

UNCLASSIFIED

/D-60

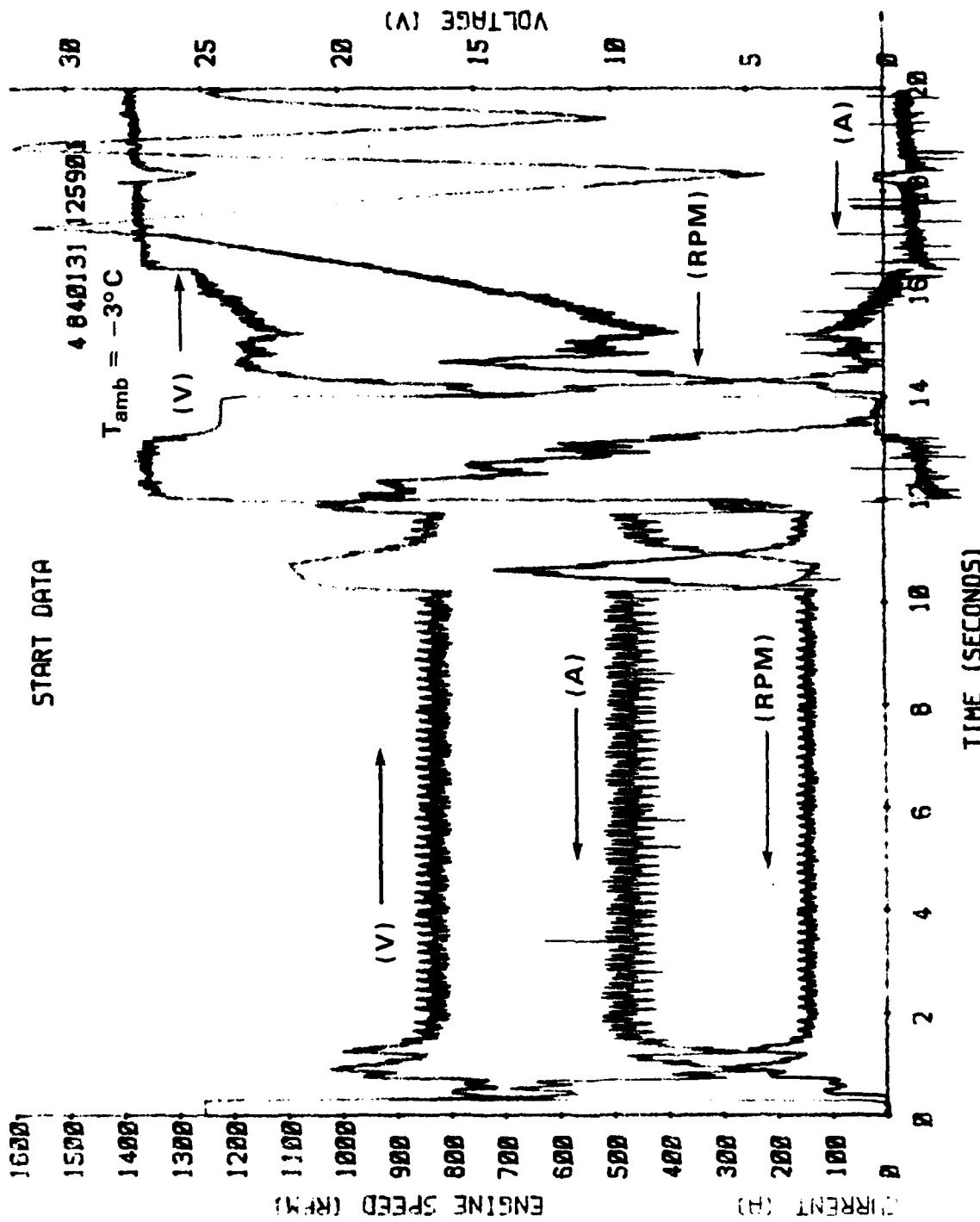


FIGURE D-31

UNCLASSIFIED

UNCLASSIFIED

/D-61

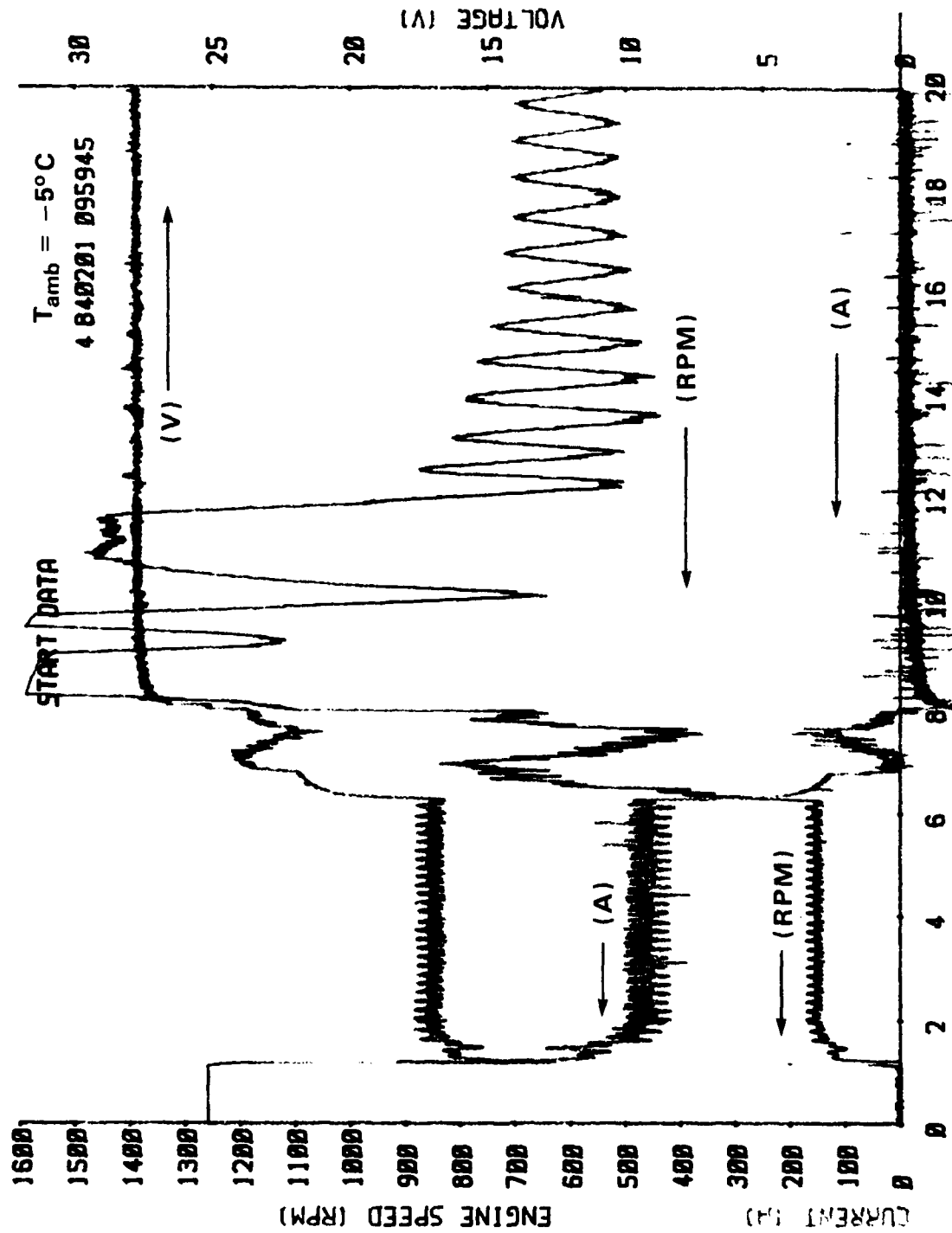
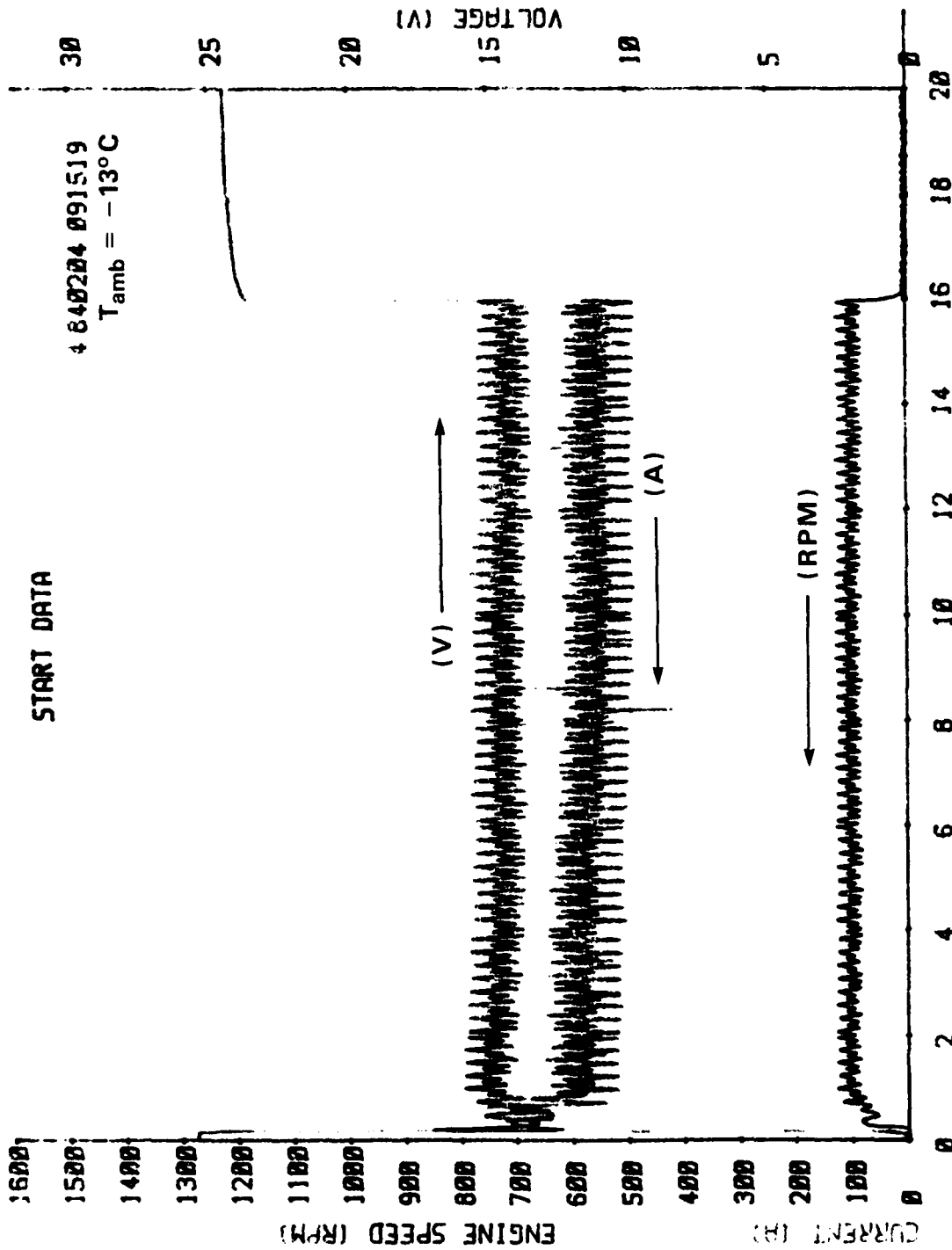


FIGURE D-32

UNCLASSIFIED

UNCLASSIFIED

/D-62



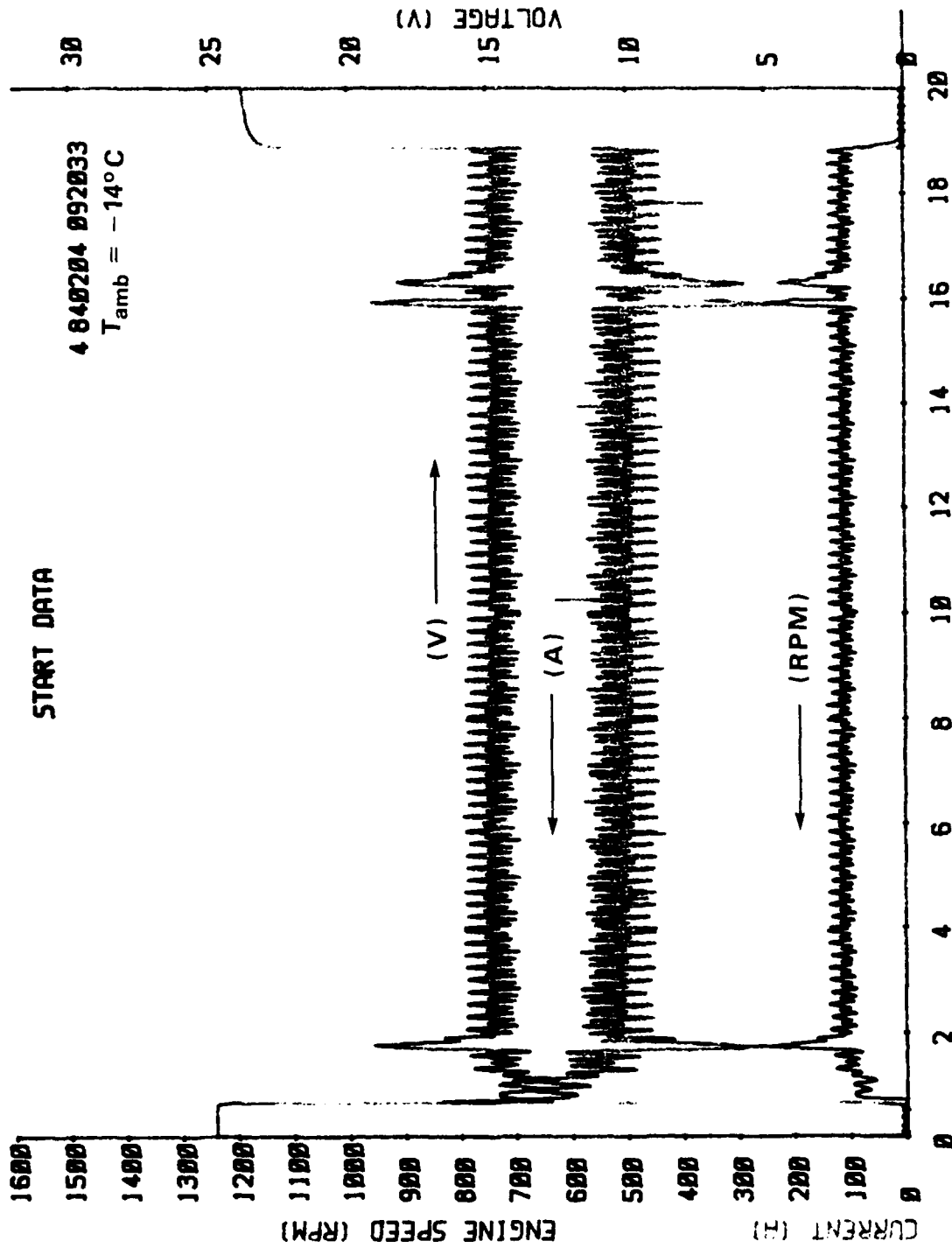
TIME (SECONDS)

FIGURE D-33

UNCLASSIFIED

UNCLASSIFIED

/ D-63



TIME (SECONDS)

FIGURE D-34

UNCLASSIFIED

UNCLASSIFIED

/D-64

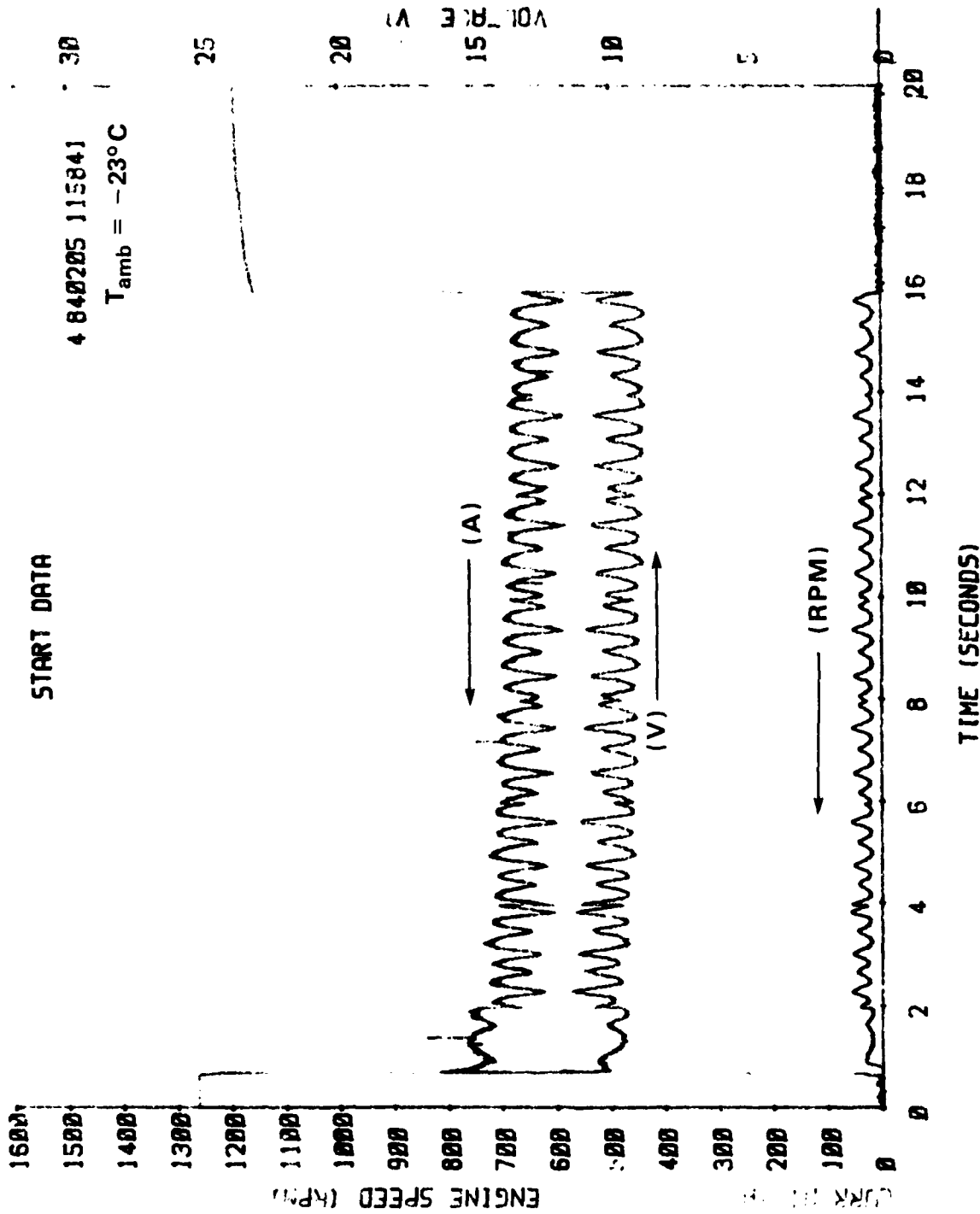
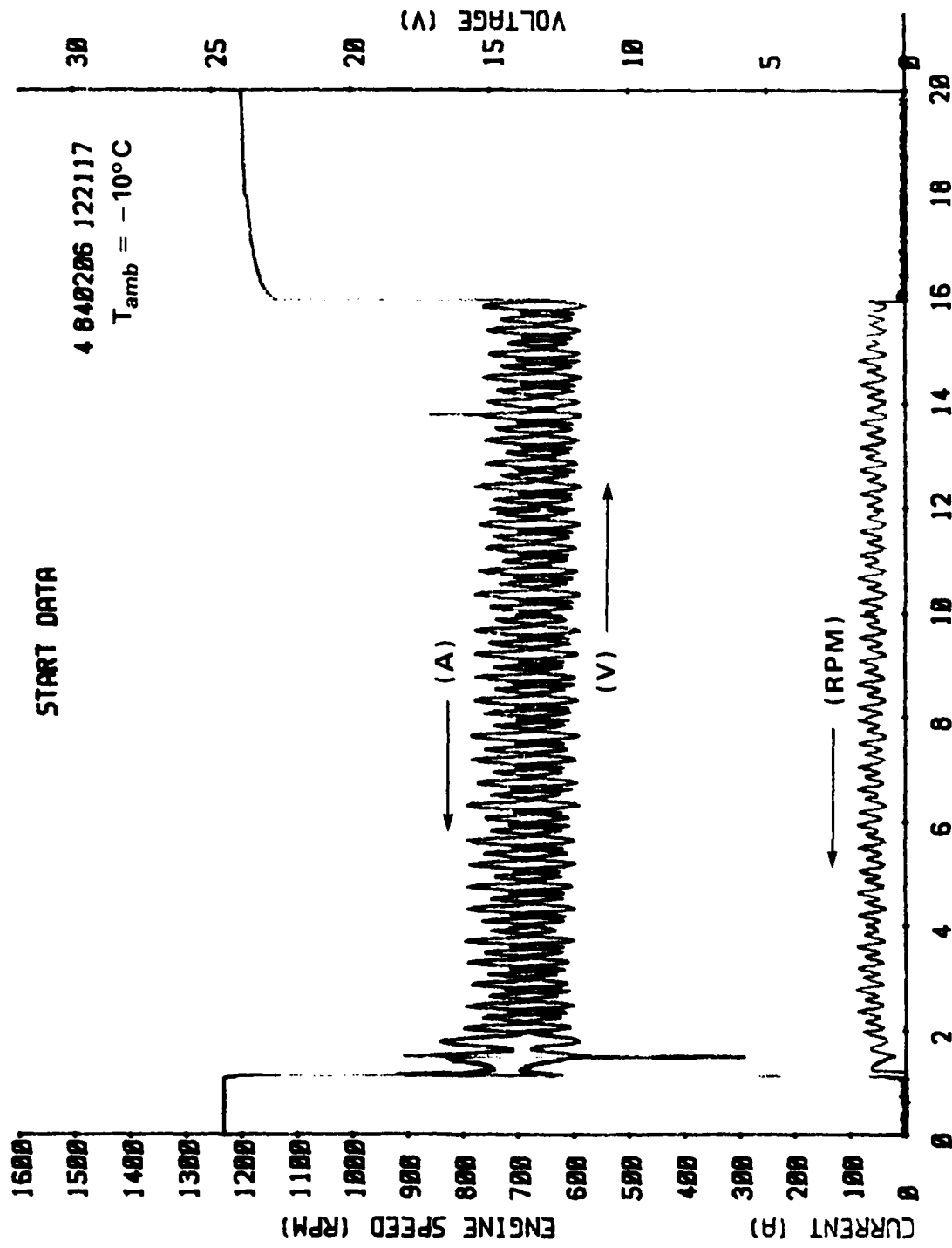


FIGURE D-35

UNCLASSIFIED

UNCLASSIFIED

/ D-65



TIME (SECONDS)

FIGURE D-36

UNCLASSIFIED

UNCLASSIFIED

/ D-66

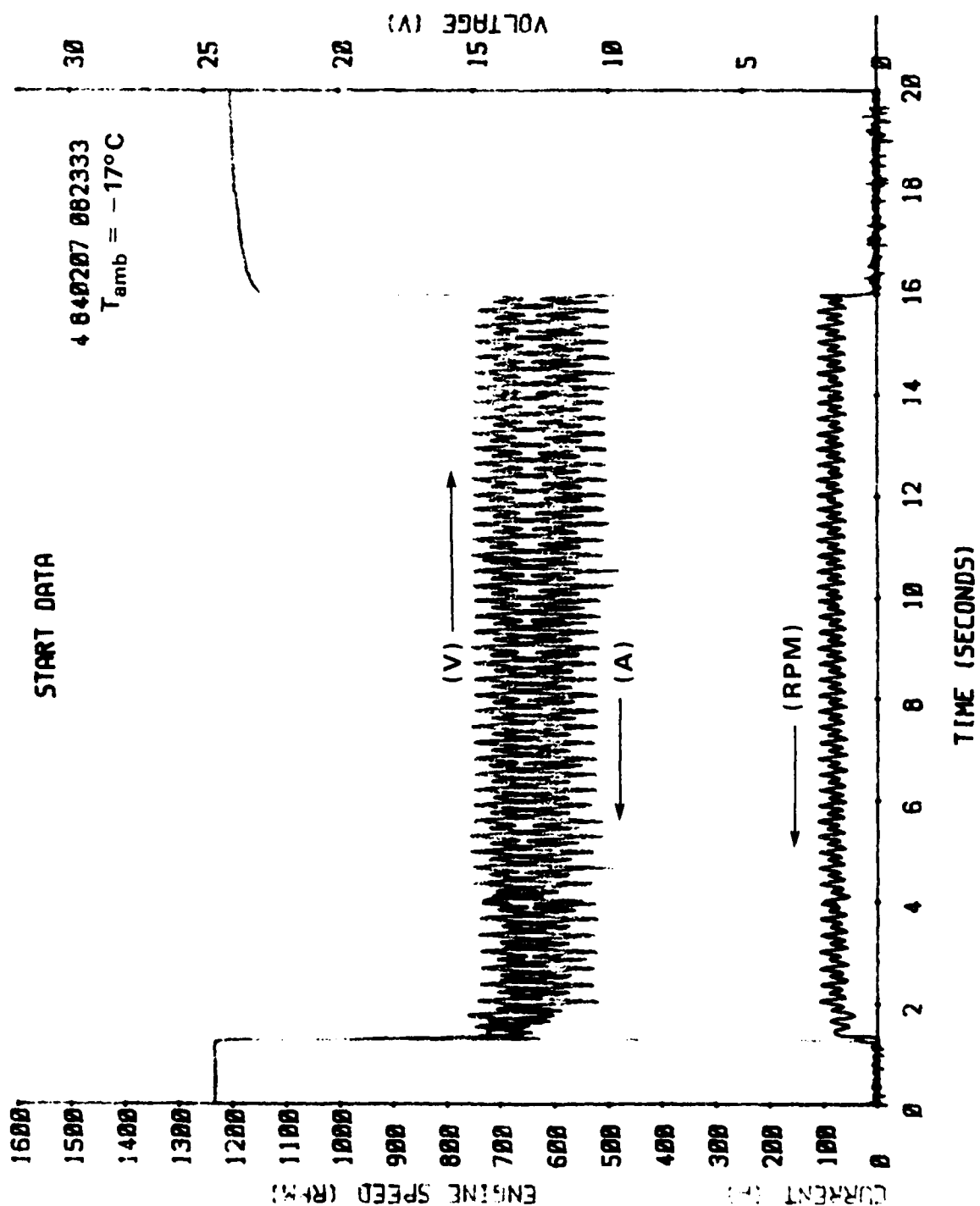


FIGURE D-37

UNCLASSIFIED

UNCLASSIFIED

/ D-67

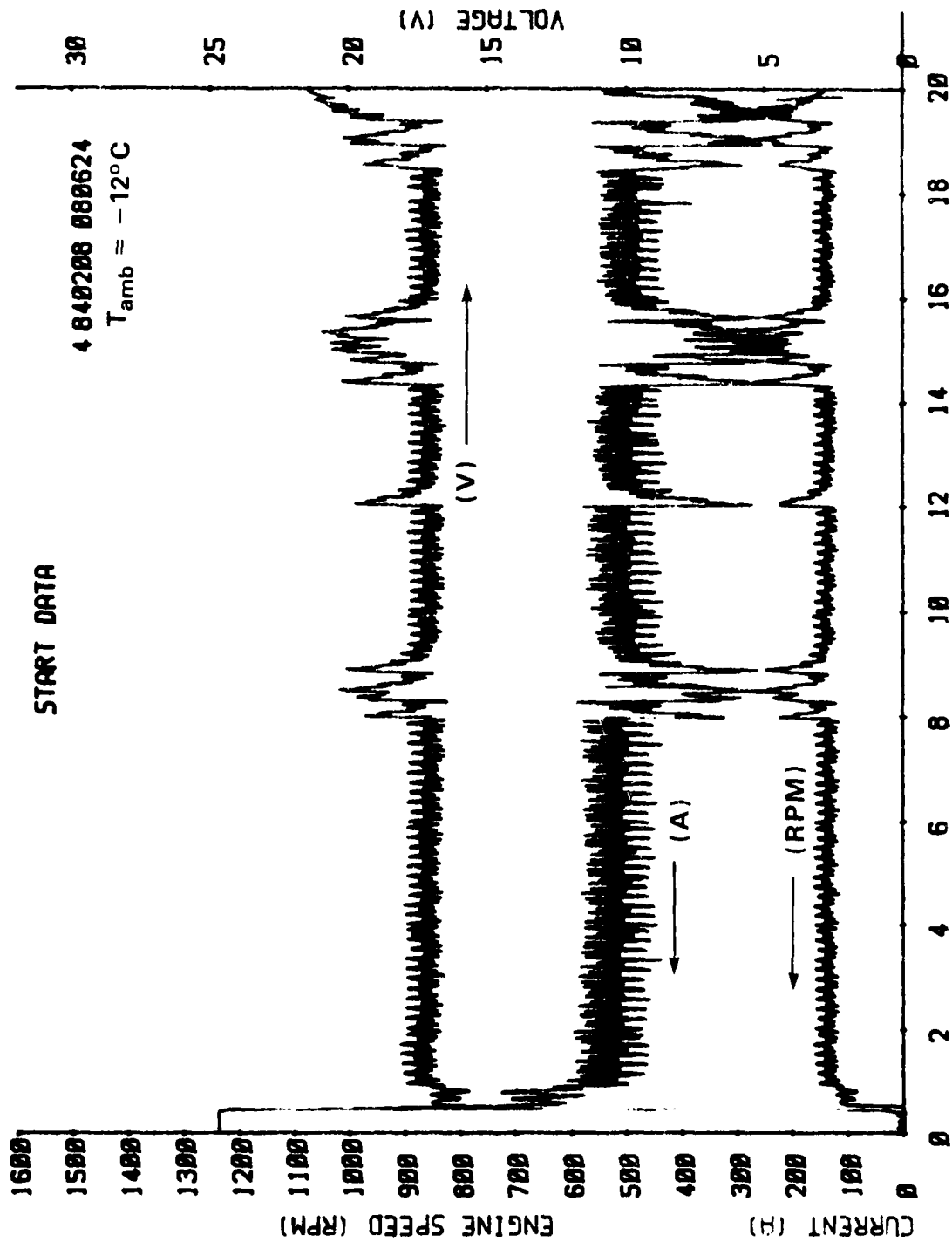
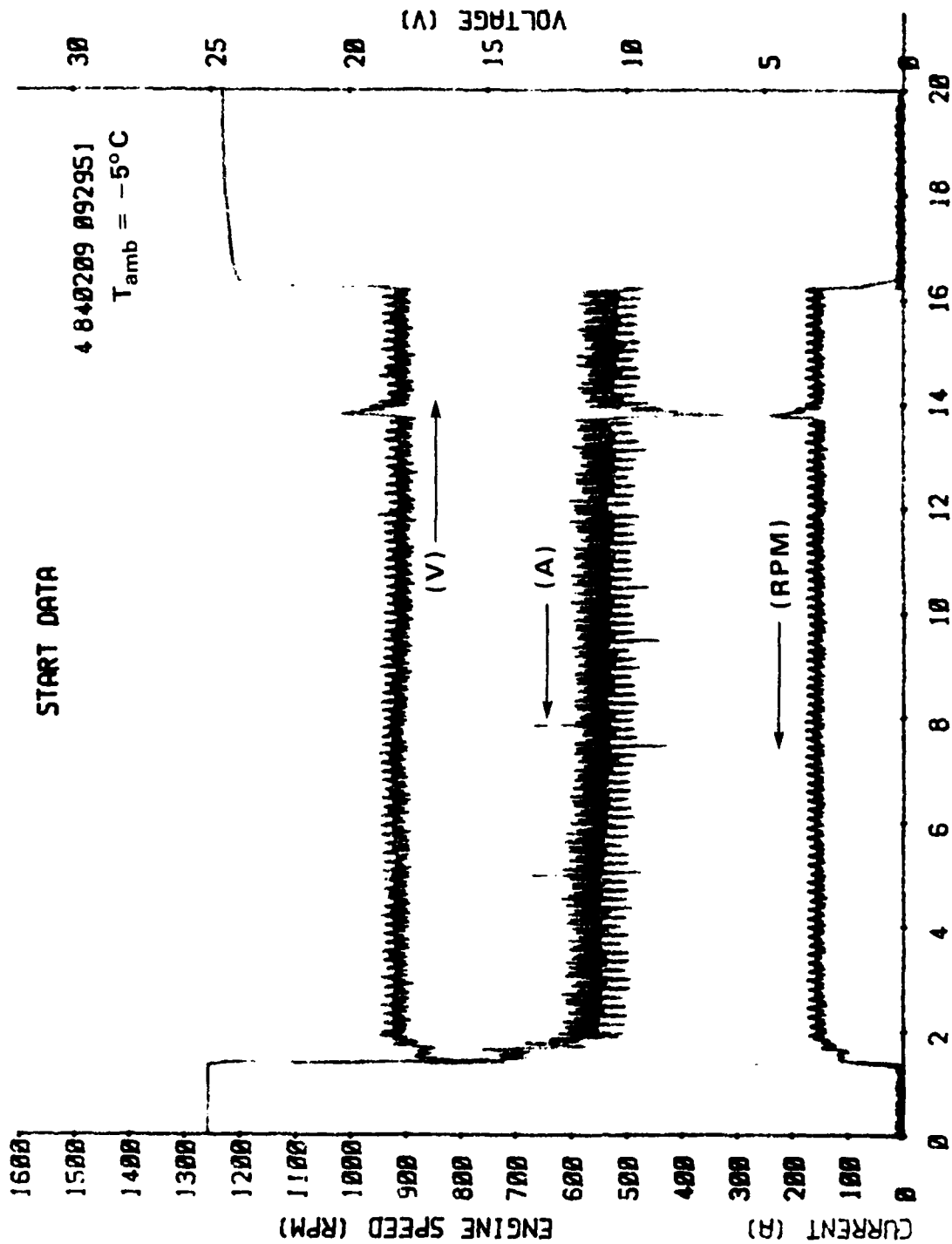


FIGURE D-38

UNCLASSIFIED

UNCLASSIFIED

/ D-68



TIME (SECONDS)

FIGURE D-39

UNCLASSIFIED

UNCLASSIFIED

/ D-69

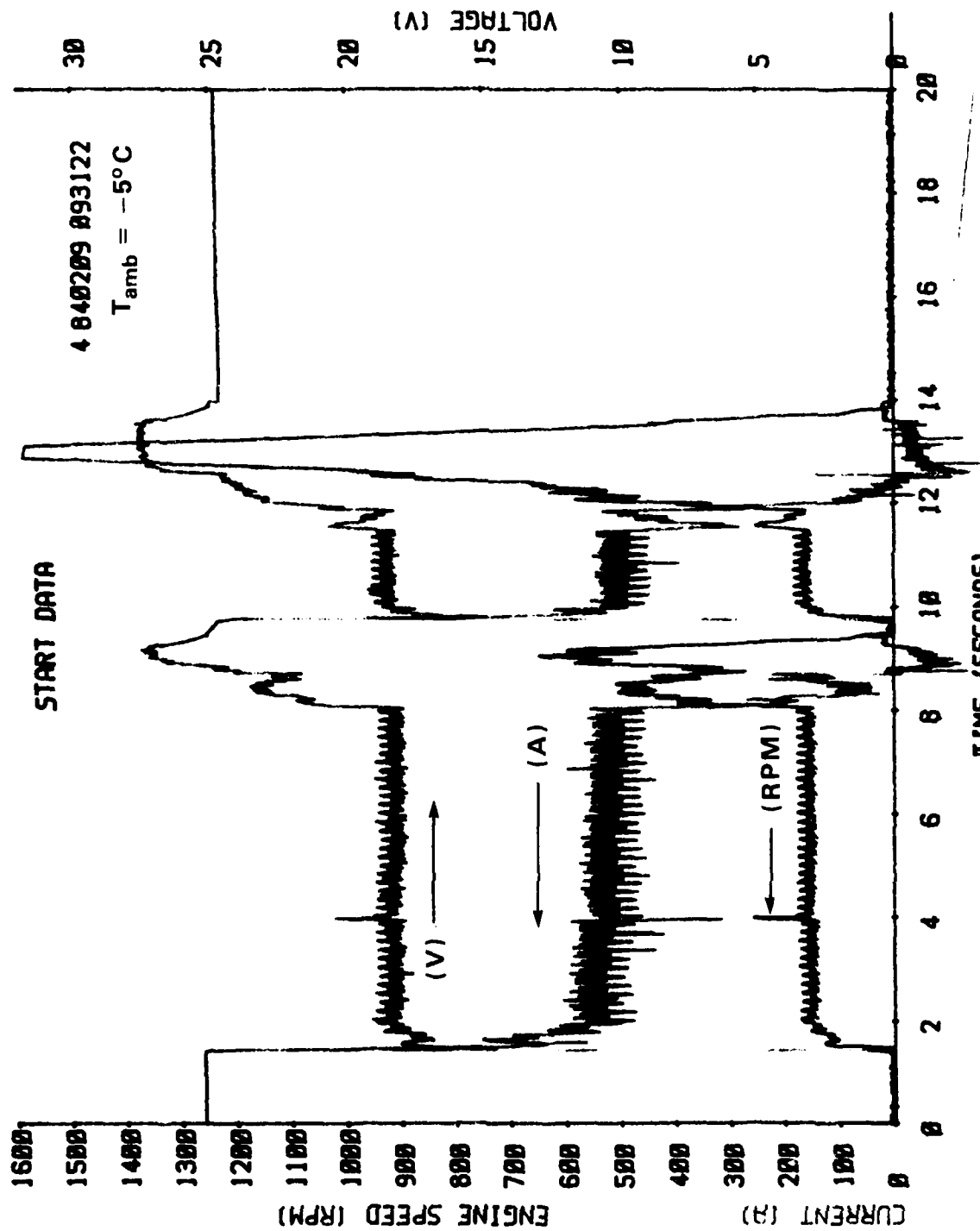


FIGURE D-40

UNCLASSIFIED

UNCLASSIFIED

/D-70

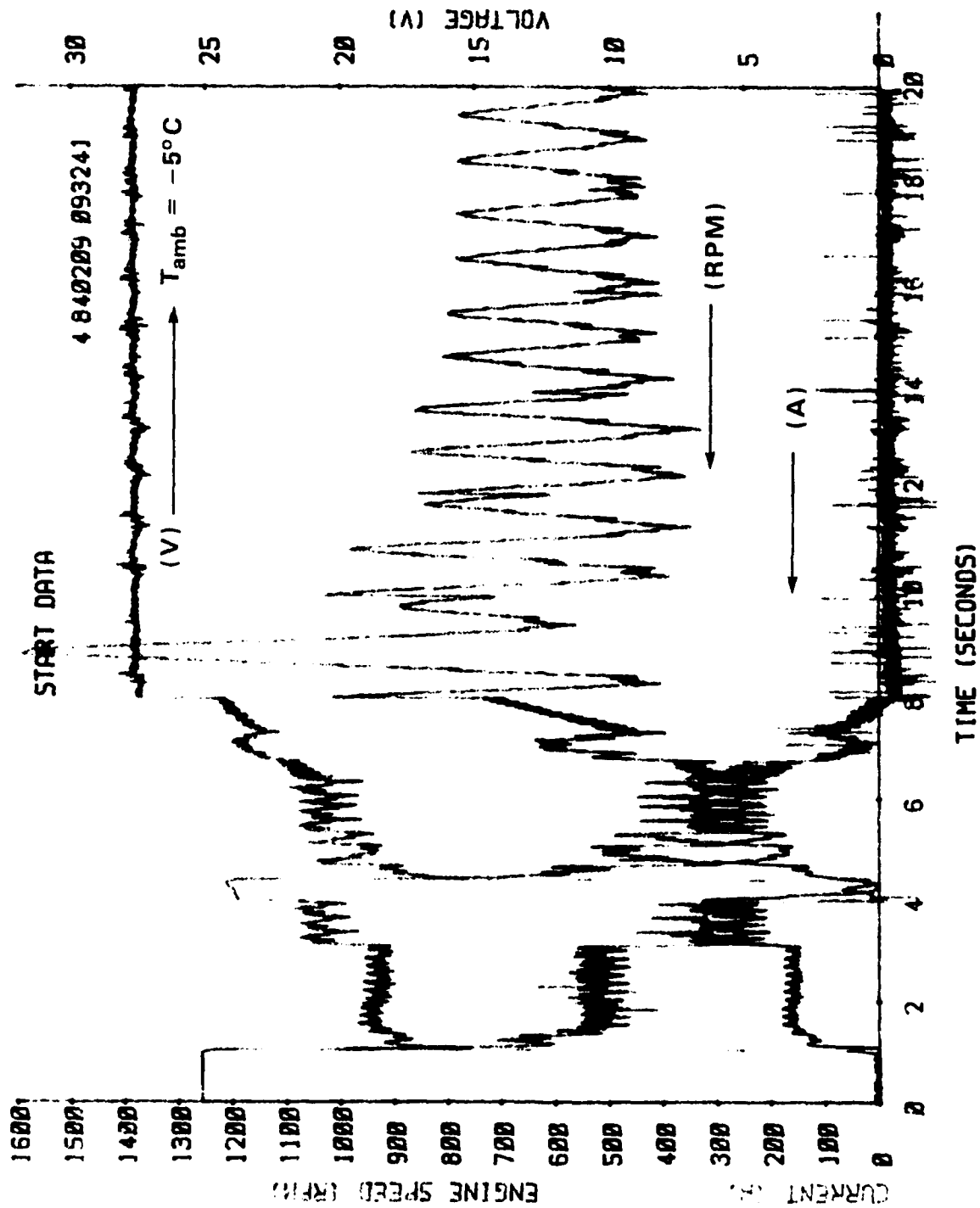


FIGURE D-42

UNCLASSIFIED

UNCLASSIFIED

/D-71

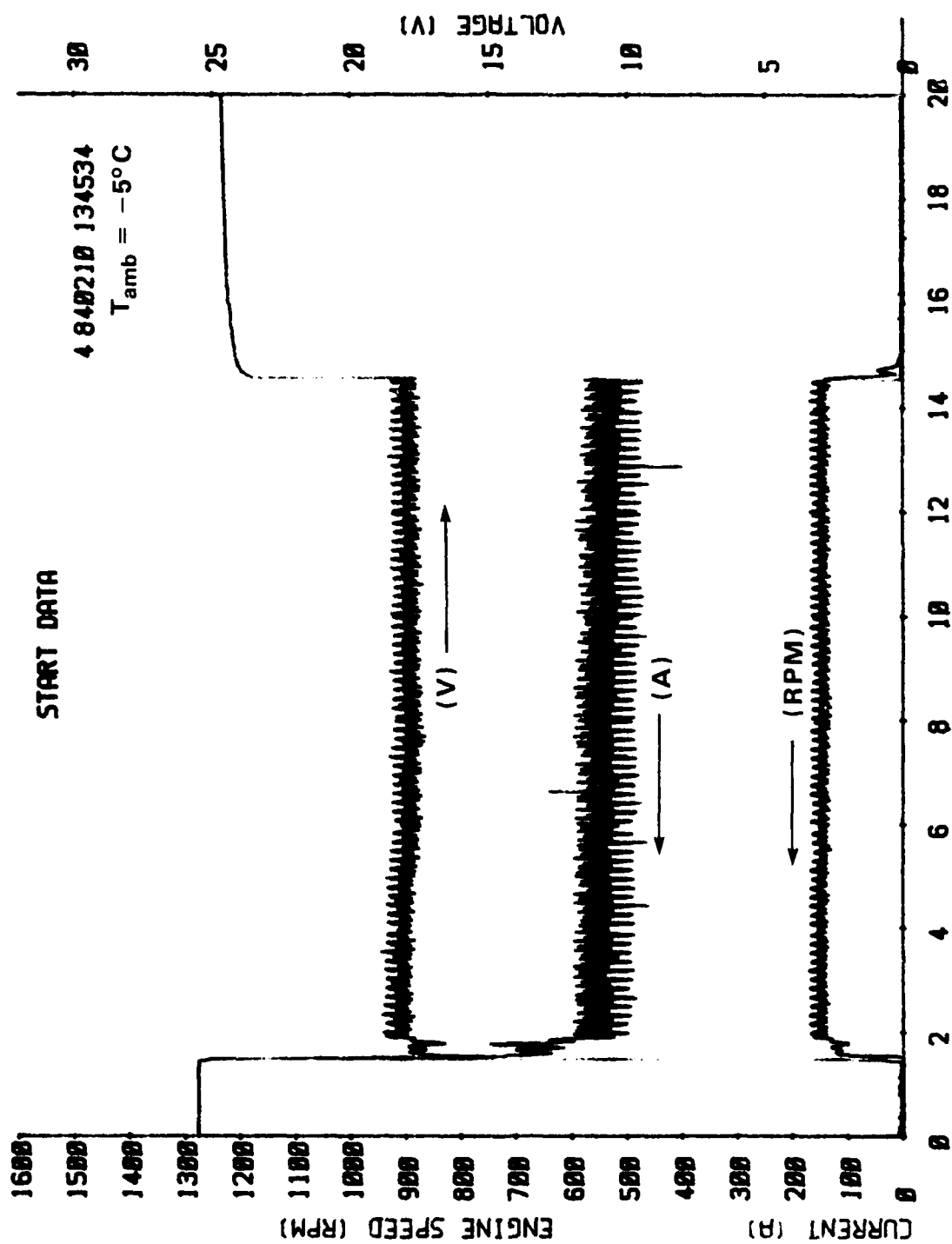


FIGURE D-41

UNCLASSIFIED

UNCLASSIFIED

D/72

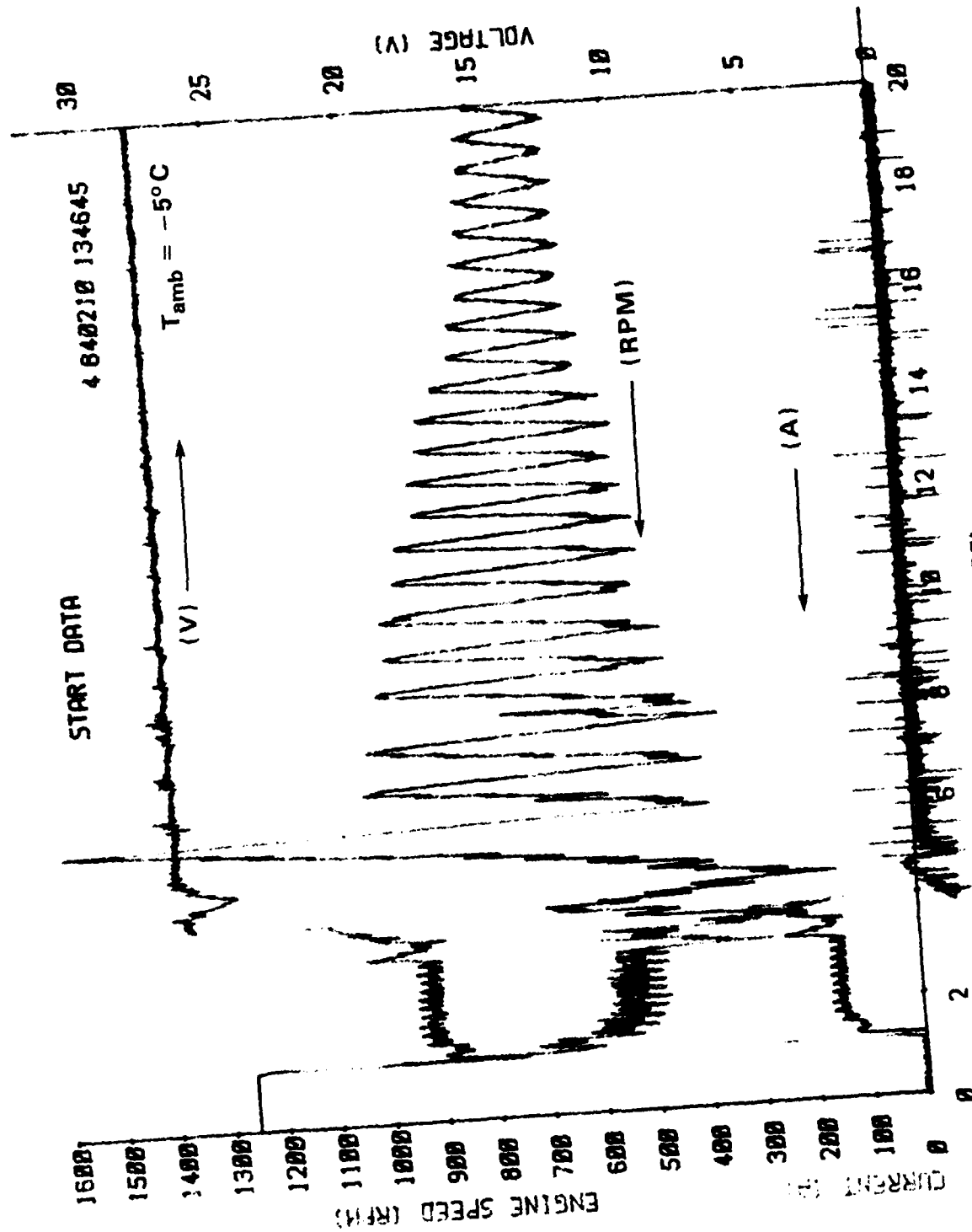


Figure D-42

UNCLASSIFIED

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1. ORIGINATING ACTIVITY Defence Research Establishment Suffield		2a. DOCUMENT SECURITY CLASSIFICATION Unclassified	
		2b. GROUP	
3. DOCUMENT TITLE Improving Low Temperature Startability of M113 Vehicles: Hot Air Heating Tests			
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) Technical Memorandum (Test Report)			
5. AUTHOR(S) (Last name, first name, middle initial) Stupich, T.F., Shankhla, V.S., Förster, W.G.			
6. DOCUMENT DATE March 1968		7a. TOTAL NO. OF PAGES	7b. NO. OF REFS 10
8a. PROJECT OR GRANT NO.		8b. ORIGINATOR'S DOCUMENT NUMBER(S) Suffield Memorandum 1165	
8c. CONTRACT NO.		9b. OTHER DOCUMENT NO.(S) (Any other numbers that may be assigned this document) ACN 27A71	
10. DISTRIBUTION STATEMENT Defence Purposes Only Unlimited			
11. SUPPLEMENTARY NOTES		12. SPONSORING ACTIVITY Defence Research Establishment Suffield Ralston, Alberta TOJ 2NO	
13. ABSTRACT <p>Tests were conducted to determine the effect of hot air heating systems on the temperatures and the starting ability of the Canadian Forces M113A1 Armoured Personnel Carrier. Results showed that M113 vehicles require heating in order to start at temperatures below -12°C. Two hot air heating systems proved to be capable of enabling vehicle starting at -16°C, which, because of unusually warm ambient conditions, was the lowest temperature that occurred during testing. One of the heating systems supplied hot air to the combustion air intake, and results suggest that this method may be capable of enabling starting at moderately cold temperatures (down to -25°C). The other system, which supplied hot exhaust gases to the engine compartment and hot exhaust-free air to the batteries and personnel compartment, appeared as though it would be capable of enabling vehicle starting at much lower temperatures. However, there was a significant amount of waste heat associated with using hot air to warm the engine on the vehicle and the condensation inherent to heating with exhaust gases caused serious problems. In addition, the Espar Swingfire pulse combustion heaters that were used as the heat source in both heating systems were found to be extremely unreliable.</p>			

KEY WORDS

cold regions vehicle operation
 low temperature starting
 armoured personnel carrier
 winter vehicle aids
 diesel vehicles
 Arctic vehicle operation
 engine heating
 pulse combustion heaters

INSTRUCTIONS

1. **ORIGINATING ACTIVITY** Enter the name and address of the organization issuing the document.
- 2a. **DOCUMENT SECURITY CLASSIFICATION** Enter the overall security classification of the document including special warning terms whenever applicable.
- 2b. **GROUP** Enter security reclassification group number. The three groups are defined in Appendix 'M' of the DRB Security Regulations.
3. **DOCUMENT TITLE** Enter the complete document title in all capital letters. Titles in all cases should be unclassified. If a sufficiently descriptive title cannot be selected without classification, show title classification with the usual one-capital-letter abbreviation in parentheses immediately following the title.
4. **DESCRIPTIVE NOTES** Enter the category of document, e.g. technical report, technical note or technical letter. If appropriate, enter the type of document, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.
5. **AUTHOR(S)** Enter the name(s) of author(s) as shown on or in the document. Enter last name, first name, middle initial. If military, show rank. The name of the principal author is an absolute minimum requirement.
6. **DOCUMENT DATE** Enter the date (month, year) of Establishment approval for publication of the document.
- 7a. **TOTAL NUMBER OF PAGES** The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.
- 7b. **NUMBER OF REFERENCES** Enter the total number of references cited in the document.
- 8a. **PROJECT OR GRANT NUMBER** If appropriate, enter the applicable research and development project or grant number under which the document was written.
- 8b. **CONTRACT NUMBER** If appropriate, enter the applicable number under which the document was written.
- 9a. **ORIGINATOR'S DOCUMENT NUMBER(S)** Enter the official document number by which the document will be identified and controlled by the originating activity. This number must be unique to this document.
- 9b. **OTHER DOCUMENT NUMBER(S)** If the document has been assigned any other document numbers (either by the originator or by the sponsor), also enter this number(s).
10. **DISTRIBUTION STATEMENT** Enter any limitations on further dissemination of the document, other than those imposed by security classification, using standard statements such as:
 - (1) "Qualified requesters may obtain copies of this document from their defence documentation center."
 - (2) "Announcement and dissemination of this document is not authorized without prior approval from originating activity."
11. **SUPPLEMENTARY NOTES** Use for additional explanatory notes.
12. **SPONSORING ACTIVITY** Enter the name of the departmental project office or laboratory sponsoring the research and development. Include address.
13. **ABSTRACT** Enter an abstract giving a brief and factual summary of the document, even though it may also appear elsewhere in the body of the document itself. It is highly desirable that the abstract of classified documents be unclassified. Each paragraph of the abstract shall end with an indication of the security classification of the information in the paragraph (unless the document itself is unclassified) represented as (TS), (S), (C), (R), or (U).

The length of the abstract should be limited to 20 single-spaced standard typewritten lines, 7 1/4 inches long.
14. **KEY WORDS** Key words are technically meaningful terms or short phrases that characterize a document and could be helpful in cataloging the document. Key words should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context.

END

DATE

FILMED

8-88

DTIC